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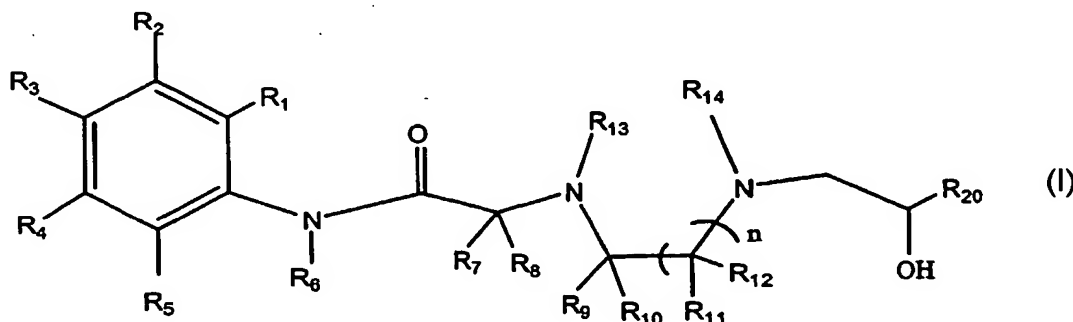
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(54) Title: **SUBSTITUTED ALKYLENE DIAMINE COMPOUNDS**



(57) Abstract: Novel compounds of the general formula (I) and pharmaceutically acceptable acid addition salts thereof, wherein the compounds are useful in therapy to protect skeletal muscles against damage resulting from trauma or to protect skeletal muscles subsequent to muscle or systemic diseases such as intermittent claudication, to treat shock conditions, to preserve donor tissue and organs used in transplants, in the treatment of cardiovascular diseases including atrial and ventricular arrhythmias, Prinzmetal's (variant) angina, stable angina, and exercise induced angina, congestive heart disease, and myocardial infarction.

**TITLE: SUBSTITUTED ALKYLENE DIAMINE COMPOUNDS****BACKGROUND OF THE INVENTION**

5        This application claims priority to U.S. Patent Application No. 60/184132 filed on February 22, 2000 the specification of which is incorporated herein by reference.

**1.     Field of the Invention**

10        The present invention is concerned with substituted piperazine compounds, therapeutic dosage forms including one or more of the compounds, and methods for treating diseases in mammals, and in particular, in a human in a therapy selected from the group including protecting skeletal muscles against damage resulting from trauma, protecting skeletal muscles subsequent to muscle or systemic diseases such as intermittent claudication, to treat shock conditions, to preserve donor tissue and organs used in transplants, and to treat cardiovascular diseases including atrial and ventricular arrhythmias, Prinzmetal's (variant) angina, stable  
15        angina, and exercise induced angina, congestive heart disease, and myocardial infarction.

**2.     Description of the Art**

20        U.S. Patent No. 4,567,264, the specification of which is incorporated herein by reference, discloses a class of substituted piperazine compounds that includes a compound known as ranolazine, ( $\pm$ )-N- (2,6-dimethylphenyl)-4-[2-hydroxy-3- (2-methoxyphenoxy)-propyl]-1-piperazineacetamide, and its pharmaceutically acceptable salts, and their use in the treatment of cardiovascular diseases, including arrhythmias, variant and exercise-induced angina, and myocardial infarction.

25        U.S. Patent No. 5,506,229, which is incorporated herein by reference, discloses the use of ranolazine and its pharmaceutically acceptable salts and esters for the treatment of tissues experiencing a physical or chemical insult, including cardioplegia, hypoxic or reperfusion injury to cardiac or skeletal muscle or brain tissue, and for use in transplants. In particular, ranolazine is particularly useful for treating arrhythmias, variant and exercise-induced angina, and myocardial infarction by partially inhibiting cardiac fatty acid oxidation. Conventional oral and parenteral ranolazine formulations are disclosed, including  
30        controlled release formulations. In particular, Example 7D of U.S. Patent No. 5,506,229 describes a controlled release formulation in capsule form comprising microspheres of ranolazine and microcrystalline cellulose coated with release controlling polymers.

Despite the important discovery that ranolazine is a very useful cardiac therapeutic agent, there remains a need for compounds that are partial fatty acid oxidation inhibitors that have a half-life greater than ranolazine and that have activities as least similar to ranolazine.

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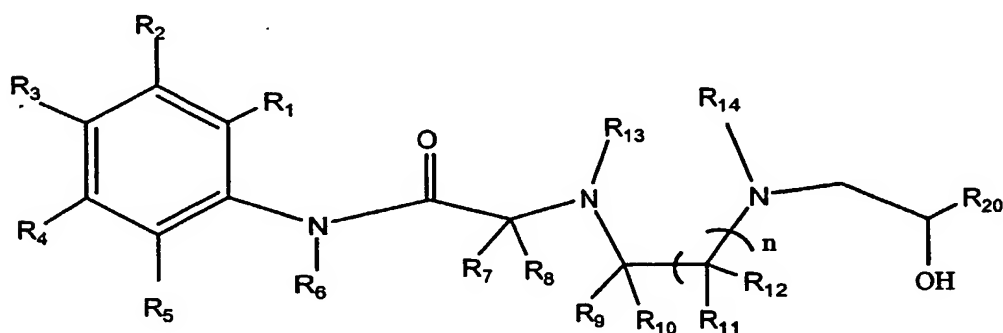
## SUMMARY OF THE INVENTION

This invention includes novel substituted piperazine compounds that are partial fatty acid oxidation inhibitors with good therapeutic half-lives.

This invention also includes novel substituted piperazine compounds that can be administered to a mammal to protect skeletal muscles against damage resulting from trauma, to protecting skeletal muscles subsequent to muscle or systemic diseases such as intermittent claudication, to treat shock conditions, to preserve donor tissue and organs used in transplants, and to treat cardiovascular diseases including atrial and ventricular arrhythmias, Prinzmetal's (variant) angina, stable angina, and exercise induced angina, congestive heart disease, and myocardial infarction.

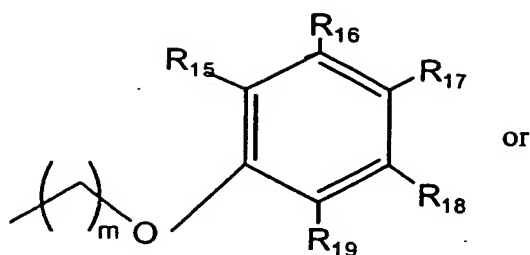
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This invention includes a class of substituted piperazine compounds having the following formula:

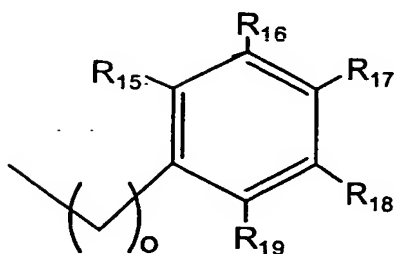


wherein R<sub>20</sub> is selected from the group consisting of

20



or



and wherein  $m = 1$  or  $2$ ,  $n = 1$  or  $2$ ,  $o = 0$  or  $1$  or  $2$ ;

$R_1$ ,  $R_2$ ,  $R_3$ ,  $R_4$  and  $R_5$  are each independently selected from the group consisting of hydrogen, halo,  $\text{NO}_2$ ,  $\text{CF}_3$ ,  $\text{CN}$ ,  $\text{OR}_{23}$ ,  $\text{SR}_{23}$ ,  $\text{N(R}_{23})_2$ ,  $\text{S(O)R}_{22}$ ,  $\text{SO}_2\text{R}_{22}$ ,  $\text{SO}_2\text{N(R}_{23})_2$ ,  $\text{NR}_{23}\text{CO}_2\text{R}_{22}$ ,  $\text{NR}_{23}\text{CON(R}_{23})_2$ ,  $\text{COR}_{23}$ ,  $\text{CO}_2\text{R}_{23}$ ,  $\text{CON(R}_{23})_2$ ,  $\text{NR}_{23}\text{SO}_2\text{R}_{22}$ ,  $\text{C}_{1-15}$  alkyl,  $\text{C}_{2-15}$  alkenyl,  $\text{C}_{2-15}$  alkynyl, heterocyclyl, aryl, and heteroaryl, wherein the alkyl and aryl substituent are optionally substituted with 1 substituent selected from the group consisting of halo,  $\text{NO}_2$ ,  $\text{CF}_3$ ,  $\text{CN}$ ,  $\text{OR}_{23}$ ,  $\text{SR}_{23}$ ,  $\text{N(R}_{23})_2$ ,  $\text{S(O)R}_{22}$ , and  $\text{SO}_2\text{R}_{22}$ ;

$R_6$ ,  $R_7$  and  $R_8$  each independently selected from the group consisting of hydrogen or  $\text{C}_{1-15}$  alkyl;

$R_9$ ,  $R_{10}$ ,  $R_{11}$ , and  $R_{12}$  are each independently selected from the group consisting of hydrogen and lower alkyl, or  $R_9$  and  $R_{10}$  may together form a carbonyl, or  $R_{11}$  and  $R_{12}$  may together form  $-(\text{CH}_2)_p$  where  $P$  is 2-6 or carbonyl;

$R_{13}$  and  $R_{14}$  are each independently selected from hydrogen and lower alkyl;

$R_{15}$ ,  $R_{16}$ ,  $R_{17}$ ,  $R_{18}$ , and  $R_{19}$  are each independently selected from the group consisting of hydrogen, halo,  $\text{NO}_2$ ,  $\text{CF}_3$ ,  $\text{CN}$ ,  $\text{OR}_{23}$ ,  $\text{SR}_{23}$ ,  $\text{N(R}_{23})_2$ ,  $\text{S(O)R}_{22}$ ,  $\text{SO}_2\text{R}_{22}$ ,  $\text{SO}_2\text{N(R}_{23})_2$ ,  $\text{NR}_{23}\text{CO}_2\text{R}_{22}$ ,  $\text{NR}_{23}\text{CON(R}_{23})_2$ ,  $\text{COR}_{23}$ ,  $\text{CO}_2\text{R}_{23}$ ,  $\text{CON(R}_{23})_2$ ,  $\text{NR}_{23}\text{SO}_2\text{R}_{22}$ ,  $\text{C}_{1-15}$  alkyl,  $\text{C}_{2-15}$  alkenyl,  $\text{C}_{2-15}$  alkynyl, heterocyclyl, aryl, and heteroaryl, wherein the alkyl and aryl substituent are optionally substituted with 1 substituent selected from the group consisting of halo,  $\text{NO}_2$ ,  $\text{CF}_3$ ,  $\text{CN}$ ,  $\text{OR}_{23}$ ,  $\text{SR}_{23}$ ,  $\text{N(R}_{23})_2$ ,  $\text{S(O)R}_{22}$ , and  $\text{SO}_2\text{R}_{22}$  and wherein two adjacent

substituents selected from the group consisting of  $R_{15}$ ,  $R_{16}$ ,  $R_{17}$ ,  $R_{18}$ , and  $R_{19}$ , may together form a ring having from 3 to 6 carbon atoms wherein from 0 to 3 of the carbon atoms may be substituted with an oxygen atom;

$R_{22}$  is selected from the group consisting of  $C_{1-15}$  alkyl, aryl, or heteroaryl, wherein the alkyl and aryl substituents are optionally substituted with 1 substituent selected from the group consisting of halo, alkyl, monoalkylamino, dialkylamino, alkyl amide, aryl amide, heteroaryl amide, CN,  $O-C_{1-6}$  alkyl,  $CF_3$ , or heteroaryl; and

$R_{23}$  is selected from the group consisting of H,  $C_{1-15}$  alkyl, aryl, or heteroaryl, wherein the alkyl and aryl substituents are optionally substituted with 1 substituent selected from the group consisting of halo, alkyl, mono- or dialkylamino, alkyl, CN,  $-O-C_{1-6}$  alkyl, or  $CF_3$ .

In another embodiment, this invention is a substituted piperazine compound selected from the group consisting of N-(2,6-dimethylphenyl)-2-[(2-{[2-hydroxy-3-(2-methoxyphenyl)propyl]methylamino}ethyl)methylamino]acetamide, N-(2,6-dimethylphenyl)-2-[(2-{[2-hydroxy-3-(2-methoxyphenoxy)propyl]methylamino}ethyl)methylamino]acetamide, N-(2,6-dimethylphenyl)-2-[(2-{[2-hydroxy-3-(2-methoxyphenoxy)propyl]methylamino}ethyl)methylamino]acetamide, 2-[(2-{[3-(2H-benzo[d]1,3-dioxolen-5-yloxy)-2-hydroxypropyl]methylamino}ethyl)methylamino]-N-(2,6-dimethylphenyl)acetamide, 2-[(2-{[3-(2,6-dichlorophenoxy)-2-hydroxypropyl]methylamino}ethyl)methylamino]-N-(2,6-dimethylphenyl)acetamide, N-(2,6-dimethylphenyl)-2-[(2-{[2-(2-chlorophenyl)-2-hydroxyethyl]ethylamino}ethyl)ethylamino]acetamide, N-(2,6-dimethylphenyl)-2-[ethyl(2-{ethyl[2-(2-fluorophenyl)-2-hydroxyethyl]amino}ethyl)amino]acetamide, 2-[(2-{[3-(2H-benzo[d]1,3-dioxolen-5-yl)-2-hydroxypropyl]ethylamino}ethyl)ethylamino]-N-(2,6-dimethylphenyl)acetamide, 2-[(2-{[3-(2H-benzo[d]1,3-dioxolen-5-yl)-2-hydroxypropyl]ethylamino}ethyl)ethylamino]-N-(2,6-dimethylphenyl)acetamide, N-(2,6-dimethylphenyl)-2-[(2-{[2-(2-hydroxy-3-phenylpropyl)methylamino]propyl}methylamino)acetamide, and 2-[(2-{[3-(2H-benzo[d]1,3-dioxolen-5-yl)-2-hydroxypropyl]methylamino]propyl}methylamino)-N-(2,6-dimethylphenyl)acetamide.

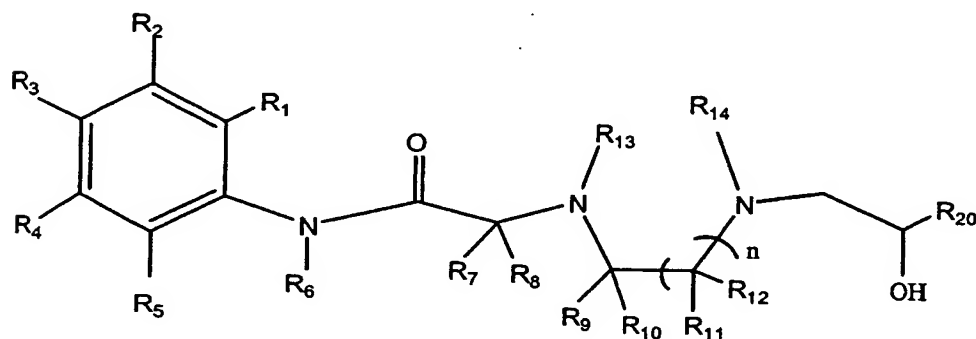
In yet another embodiment, this invention is a method for administering one or more composition of this invention to a mammal in a treatment selected from the group consisting of protecting skeletal muscles against damage resulting from trauma, protecting skeletal muscles subsequent to muscle or systemic diseases such as intermittent claudication, to treat

shock conditions, to preserve donor tissue and organs used in transplants, and to treat cardiovascular diseases including atrial and ventricular arrhythmias, Prinzmetal's (variant) angina, stable angina, and exercise induced angina, congestive heart disease, and myocardial infarction.

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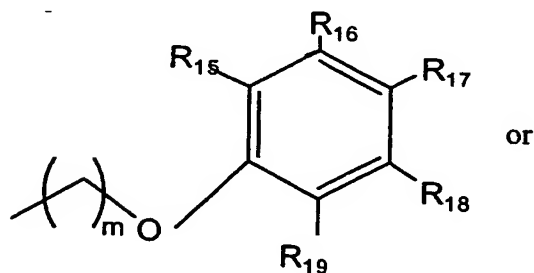
### DETAILED DESCRIPTION OF THE INVENTION

This invention concerns substituted piperazine compounds having the following formula:

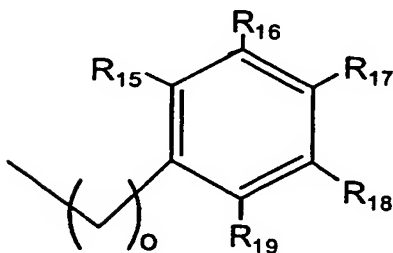


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wherein  $R_{20}$  is selected from the group consisting of



or



wherein  $m = 1$  or  $2$ ,  $n = 1$  or  $2$ ,  $o = 0$  or  $1$  or  $2$ ;

$R_1$ ,  $R_2$ ,  $R_3$ ,  $R_4$  and  $R_5$  are each independently selected from the group consisting of hydrogen, halo,  $\text{NO}_2$ ,  $\text{CF}_3$ , CN,  $\text{OR}_{23}$ ,  $\text{SR}_{23}$ ,  $\text{N}(\text{R}_{23})_2$ ,  $\text{S}(\text{O})\text{R}_{22}$ ,  $\text{SO}_2\text{R}_{22}$ ,  $\text{SO}_2\text{N}(\text{R}_{23})_2$ ,  $\text{NR}_{23}\text{CO}_2\text{R}_{22}$ ,  $\text{NR}_{23}\text{CON}(\text{R}_{23})_2$ ,  $\text{COR}_{23}$ ,  $\text{CO}_2\text{R}_{23}$ ,  $\text{CON}(\text{R}_{23})_2$ ,  $\text{NR}_{23}\text{SO}_2\text{R}_{22}$ ,  $\text{C}_{1-15}$  alkyl,  $\text{C}_{2-15}$  alkenyl,  $\text{C}_{2-15}$  alkynyl, heterocyclyl, aryl, and heteroaryl, wherein the alkyl and aryl  
5 substituent are optionally substituted with 1 substituent selected from the group consisting of halo,  $\text{NO}_2$ ,  $\text{CF}_3$ , CN,  $\text{OR}_{23}$ ,  $\text{SR}_{23}$ ,  $\text{N}(\text{R}_{23})_2$ ,  $\text{S}(\text{O})\text{R}_{22}$ , and  $\text{SO}_2\text{R}_{22}$ ;

$R_6$ ,  $R_7$  and  $R_8$  each independently selected from the group consisting of hydrogen or  $\text{C}_{1-15}$  alkyl;

$R_9$ ,  $R_{10}$ ,  $R_{11}$ , and  $R_{12}$  are each independently selected from the group consisting of  
10 hydrogen and lower alkyl, or  $R_9$  and  $R_{10}$  may together form a carbonyl, or  $R_{11}$  and  $R_{12}$  may together form  $-(\text{CH}_2)_p$  where P is 2-6 or carbonyl;

$R_{13}$  and  $R_{14}$  are each independently selected from hydrogen and lower alkyl;

$R_{15}$ ,  $R_{16}$ ,  $R_{17}$ ,  $R_{18}$ , and  $R_{19}$  are each independently selected from the group consisting of  
15 hydrogen, halo,  $\text{NO}_2$ ,  $\text{CF}_3$ , CN,  $\text{OR}_{23}$ ,  $\text{SR}_{23}$ ,  $\text{N}(\text{R}_{23})_2$ ,  $\text{S}(\text{O})\text{R}_{22}$ ,  $\text{SO}_2\text{R}_{22}$ ,  $\text{SO}_2\text{N}(\text{R}_{23})_2$ ,  $\text{NR}_{23}\text{CO}_2\text{R}_{22}$ ,  $\text{NR}_{23}\text{CON}(\text{R}_{23})_2$ ,  $\text{COR}_{23}$ ,  $\text{CO}_2\text{R}_{23}$ ,  $\text{CON}(\text{R}_{23})_2$ ,  $\text{NR}_{23}\text{SO}_2\text{R}_{22}$ ,  $\text{C}_{1-15}$  alkyl,  $\text{C}_{2-15}$  alkenyl,  $\text{C}_{2-15}$  alkynyl, heterocyclyl, aryl, and heteroaryl, wherein the alkyl and aryl substituent are optionally substituted with 1 substituent selected from the group consisting of halo,  $\text{NO}_2$ ,  $\text{CF}_3$ , CN,  $\text{OR}_{23}$ ,  $\text{SR}_{23}$ ,  $\text{N}(\text{R}_{23})_2$ ,  $\text{S}(\text{O})\text{R}_{22}$ , and  $\text{SO}_2\text{R}_{22}$  and wherein two adjacent substituents selected from the group consisting of  $R_{15}$ ,  $R_{16}$ ,  $R_{17}$ ,  $R_{18}$ , and  $R_{19}$ , may together form  
20 a ring having from 3 to 6 carbon atoms wherein from 0 to 3 of the carbon atoms may be substituted with an oxygen atom;

$R_{22}$  is selected from the group consisting of  $\text{C}_{1-15}$  alkyl, aryl, or heteroaryl, wherein the alkyl and aryl substituents are optionally substituted with 1 substituent selected from the group consisting of halo, alkyl, monoalkylamino, dialkylamino, alkyl amide, aryl amide,  
25 heteroaryl amide, CN,  $\text{O}-\text{C}_{1-6}$  alkyl,  $\text{CF}_3$ , or heteroaryl; and

$R_{23}$  is selected from the group consisting of H,  $\text{C}_{1-15}$  alkyl, aryl, or heteroaryl, wherein the alkyl and aryl substituents are optionally substituted with 1 substituent selected from the group consisting of halo, alkyl, mono- or dialkylamino, alkyl, CN,  $-\text{O}-\text{C}_{1-6}$  alkyl, or  $\text{CF}_3$ .

In other compounds of this invention,  $\text{R}^1$ ,  $\text{R}^2$ ,  $\text{R}^3$ ,  $\text{R}^4$  and  $\text{R}^5$  are each independently  
30 selected from the group consisting of hydrogen, halo,  $\text{CF}_3$ ,  $\text{OR}^{22}$  and  $\text{C}_{1-4}$  alkyl and wherein  $\text{R}^{22}$  is a  $\text{C}_{1-3}$  alkyl;

$\text{R}^6$ ,  $\text{R}^7$  and  $\text{R}^8$  each independently selected from the group consisting of hydrogen and  $\text{C}_{1-3}$  alkyl;

$R_9$ ,  $R_{10}$ ,  $R_{11}$ , and  $R_{12}$  are each independently selected from the group consisting of hydrogen and  $C_{1-4}$  alkyl, or  $R_9$  and  $R_{10}$  may together form a carbonyl, or  $R_{11}$  and  $R_{12}$  may together form  $-(CH_2)_p$  where  $P$  is 2-6 or carbonyl;

$R_{13}$  and  $R_{14}$  are each independently selected from  $C_{1-4}$  alkyl;

5  $R^{15}$ ,  $R^{16}$ ,  $R^{17}$ ,  $R^{18}$ , and  $R^{19}$ , are each independently selected from the group consisting of hydrogen, halo,  $CF_3$ ,  $CN$ ,  $OR^{22}$ ,  $S(O)R^{22}$ ,  $SO_2R^{22}$ ,  $SON(R^{22})_2$ ,  $CON(R^{22})_2$ ,  $C_{1-4}$  alkyl wherein  $R^{22}$  is  $C_{1-3}$  alkyl, or  $R^{15}$  and  $R^{16}$  may together form  $-CH=CH-CH=CH-$ , or  $R^{16}$  and  $R^{17}$  may together form  $-OCH_2O-$ ; and

10  $R_{22}$  is selected from the group consisting of  $C_{1-4}$  alkyl, aryl, or heteroaryl, wherein the alkyl and aryl substituents are optionally substituted with 1 substituent selected from the group consisting of halo, alkyl,  $O-C_{1-3}$  alkyl, or  $CF_3$ .

In still other compounds of this invention,  $R^1$ ,  $R^2$ ,  $R^3$ ,  $R^4$  and  $R^5$  are each independently selected from the group consisting of hydrogen and  $C_{1-2}$  alkyl;

$R^6$ ,  $R^7$  and  $R^8$  each hydrogen;

15  $R_9$ ,  $R_{10}$ ,  $R_{11}$ , and  $R_{12}$  are each independently selected from the group consisting of hydrogen and  $C_{1-2}$  alkyl;

$R_{13}$  and  $R_{14}$  are selected from the group consisting of hydrogen and  $C_{1-2}$  alkyl; and

20  $R^{15}$ ,  $R^{16}$ ,  $R^{17}$ ,  $R^{18}$ , and  $R^{19}$ , are each independently selected from the group consisting of hydrogen, halo,  $CF_3$ ,  $OR^{22}$ , or methyl wherein  $R^{22}$  is  $C_{1-3}$  alkyl, or  $R^{15}$  and  $R^{16}$  may together form  $-CH=CH-CH=CH-$ , or  $R^{16}$  and  $R^{17}$  may together form  $-OCH_2O-$ .

In yet other compounds of this invention,  $n = 1$ ,  $m = 1$ ; and  $o = 1$

$R^2$ ,  $R^3$ , and  $R^4$  are each hydrogen and  $R^1$  and  $R^5$  are each methyl;

$R^6$ ,  $R^7$ ,  $R^8$ ,  $R^9$ ,  $R^{10}$ ,  $R^{11}$ , and  $R^{12}$  are each hydrogen;

$R^{13}$  and  $R^{14}$  are each selected from the group consisting of hydrogen and  $C_{1-2}$  alkyl;

25  $R^{15}$  is selected from the group consisting of methoxy, hydrogen and  $Cl$ , or  $R^{15}$  and  $R^{16}$  may together form  $-CH=CH-CH=CH-$ ; and

$R^{16}$ ,  $R^{17}$ ,  $R^{18}$ , and  $R^{19}$ , are each independently selected from the group consisting of hydrogen and or  $R^{16}$  and  $R^{17}$  may together form  $-OCH_2O-$ .

Preferred compounds of this invention are selected from the group of compounds  
30 consisting of N-(2,6-dimethylphenyl)-2-[(2-{[2-hydroxy-3-(2-methoxyphenyl)propyl]methylamino}ethyl)methylamino]acetamide, N-(2,6-dimethylphenyl)-2-[(2-{[2-hydroxy-3-naphthylpropyl]methylamino}ethyl)methylamino]acetamide, N-(2,6-dimethylphenyl)-2-[(2-{[2-hydroxy-3-(2-methoxyphenoxy)propyl]methylamino}ethyl)methylamino]acetamide, 2-[(2-{[3-(2H-



benzo[d]1,3-dioxolen-5-yloxy)-2-hydroxypropyl)methylamino]ethyl)methylamino)- N-({2,6-dimethylphenyl)acetamide, 2-[(2-{{3-(2,6-dichlorophenoxy)-2-hydroxypropyl)methylamino]ethyl)methylamino)- N-({2,6-dimethylphenyl)acetamide, N-(2,6-dimethylphenyl)-2-[(2-{{2-(2-chlorophenyl)-2-hydroxyethyl]ethylamino}ethyl)ethylamino]acetamide, N-(2,6-dimethylphenyl)-2-[ethyl(2-{ethyl[2-(2-fluorophenyl)-2-hydroxyethyl]amino}ethyl)amino] acetamide, 2-({2-[(3-(2H-benzo[d]1,3-dioxolen-5-yl)-2-hydroxypropyl)ethylamino]ethyl}ethylamino)-N-(2,6-dimethylphenyl)acetamide, 2-({2-[(3-(2H-benzo[d]1,3-dioxolen-5-yl)-2-hydroxypropyl)ethylamino]ethyl}ethylamino)-N-(2,6-dimethylphenyl)acetamide, N-(2,6-dimethylphenyl)-2-({3-[(2-hydroxy-3-phenylpropyl)methylamino]propyl}methylamino)acetamide, and 2-({3-[(3-(2H-benzo[d]1,3-dioxolen-5-yl)-2-hydroxypropyl)methylamino]propyl}methylamino)-N-(2,6-dimethylphenyl)acetamide.

The following definitions apply to terms as used herein.

15 "Halo" or "Halogen" - alone or in combination means all halogens, that is, chloro (Cl), fluoro (F), bromo (Br), iodo (I).

"Hydroxyl" refers to the group -OH.

"Thiol" or "mercapto" refers to the group -SH.

20 "Alkyl" - alone or in combination means an alkane-derived radical containing from 1 to 20, preferably 1 to 15, carbon atoms (unless specifically defined). It is a straight chain alkyl, branched alkyl or cycloalkyl. Preferably, straight or branched alkyl groups containing from 1-15, more preferably 1 to 8, even more preferably 1-6, yet more preferably 1-4 and most preferably 1-2, carbon atoms, such as methyl, ethyl, propyl, isopropyl, butyl, t-butyl and the like. The term "lower alkyl" is used herein to describe the straight chain alkyl groups  
 25 described immediately above. Preferably, cycloalkyl groups are monocyclic, bicyclic or tricyclic ring systems of 3-8, more preferably 3-6, ring members per ring, such as cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, adamantyl and the like. Alkyl also includes a straight chain or branched alkyl group that contains or is interrupted by a cycloalkyl portion. The straight chain or branched alkyl group is attached at any available point to produce a stable  
 30 compound. Examples of this include, but are not limited to, 4-(isopropyl)-cyclohexylethyl or 2-methyl-cyclopropylpentyl. A substituted alkyl is a straight chain alkyl, branched alkyl, or cycloalkyl group defined previously, independently substituted with 1 to 3 groups or substituents of halo, hydroxy, alkoxy, alkylthio, alkylsulfinyl, alkylsulfonyl, acyloxy, aryloxy,

heteroaryloxy, amino optionally mono- or di-substituted with alkyl, aryl or heteroaryl groups, amidino, urea optionally substituted with alkyl, aryl, heteroaryl or heterocyclyl groups, aminosulfonyl optionally N-mono- or N,N-di-substituted with alkyl, aryl or heteroaryl groups, alkylsulfonylamino, arylsulfonylamino, heteroarylsulfonylamino, alkylcarbonylamino, arylcarbonylamino, heteroarylcarbonylamino, or the like.

“Alkenyl” - alone or in combination means a straight, branched, or cyclic hydrocarbon containing 2-20, preferably 2-17, more preferably 2-10, even more preferably 2-8, most preferably 2 to 4 carbon atoms with at least one, preferably 1-3, more preferably 1-2, and most preferably one, carbon to carbon double bond. In the case of a cycloalkyl group, conjugation of more than one carbon to carbon double bond is not such as to confer aromaticity to the ring. Carbon to carbon double bonds may be either contained within a cycloalkyl portion, with the exception of cyclopropyl, or within a straight chain or branched portion. Examples of alkenyl groups include ethenyl, propenyl, isopropenyl, butenyl, cyclohexenyl, cyclohexenylalkyl and the like. A substituted alkenyl is the straight chain alkenyl, branched alkenyl or cycloalkenyl group defined previously, independently substituted with 1 to 3 groups or substituents of halo, hydroxy, alkoxy, alkylthio, alkylsulfinyl, alkylsulfonyl, acyloxy, aryloxy, heteroaryloxy, amino optionally mono- or di-substituted with alkyl, aryl or heteroaryl groups, amidino, urea optionally substituted with alkyl, aryl, heteroaryl or heterocyclyl groups, aminosulfonyl optionally N-mono- or N,N-di-substituted with alkyl, aryl or heteroaryl groups, alkylsulfonylamino, arylsulfonylamino, heteroarylsulfonylamino, alkylcarbonylamino, arylcarbonylamino, heteroarylcarbonylamino, carboxy, alkoxycarbonyl, aryloxy, heteroaryloxy, or the like attached at any available point to produce a stable compound.

“Alkynyl” - alone or in combination means a straight or branched hydrocarbon containing 2-20, preferably 2-17, more preferably 2-10, even more preferably 2-8, most preferably 2-4, carbon atoms containing at least one, preferably one, carbon to carbon triple bond. Examples of alkynyl groups include ethynyl, propynyl, butynyl and the like. A substituted alkynyl refers to the straight chain alkynyl or branched alkynyl defined previously, independently substituted with 1 to 3 groups or substituents of halo, hydroxy, alkoxy, alkylthio, alkylsulfinyl, alkylsulfonyl, acyloxy, aryloxy, heteroaryloxy, amino optionally mono- or di-substituted with alkyl, aryl or heteroaryl groups, amidino, urea optionally substituted with alkyl, aryl, heteroaryl or heterocyclyl groups, aminosulfonyl optionally N-mono- or N,N-di-substituted with alkyl, aryl or heteroaryl groups, alkylsulfonylamino, arylsulfonylamino, heteroarylsulfonylamino, alkylcarbonylamino, arylcarbonylamino,

heteroarylcarbonylamino, or the like attached at any available point to produce a stable compound.

“Alkyl alkenyl” refers to a group  $-R-CR'=CR''R'''$ , where R is lower alkyl, or substituted lower alkyl, R', R'', R''' may independently be hydrogen, halogen, lower alkyl, substituted lower alkyl, acyl, aryl, substituted aryl, hetaryl, or substituted hetaryl as defined below.

“Alkyl alkynyl” refers to a groups  $-RC\equiv CR'$  where R is lower alkyl or substituted lower alkyl, R' is hydrogen, lower alkyl, substituted lower alkyl, acyl, aryl, substituted aryl, hetaryl, or substituted hetaryl as defined below.

“Alkoxy” denotes the group  $-OR$ , where R is lower alkyl, substituted lower alkyl, acyl, aryl, substituted aryl, aralkyl, substituted aralkyl, heteroalkyl, heteroarylalkyl, cycloalkyl, substituted cycloalkyl, cycloheteroalkyl, or substituted cycloheteroalkyl as defined.

“Alkylthio” denotes the group  $-SR$ ,  $-S(O)_{n=1-2}-R$ , where R is lower alkyl, substituted lower alkyl, aryl, substituted aryl, aralkyl or substituted aralkyl as defined herein.

“Acyl” denotes groups  $-C(O)R$ , where R is hydrogen, lower alkyl substituted lower alkyl, aryl, substituted aryl and the like as defined herein.

“Aryloxy” denotes groups  $-OAr$ , where Ar is an aryl, substituted aryl, heteroaryl, or substituted heteroaryl group as defined herein.

“Amino” denotes the group  $NRR'$ , where R and R' may independently be hydrogen, lower alkyl, substituted lower alkyl, aryl, substituted aryl, hetaryl, or substituted hetaryl as defined herein or acyl.

“Amido” denotes the group  $-C(O)NRR'$ , where R and R' may independently be hydrogen, lower alkyl, substituted lower alkyl, aryl, substituted aryl, hetaryl, substituted hetaryl as defined herein.

“Carboxyl” denotes the group  $-C(O)OR$ , where R is hydrogen, lower alkyl, substituted lower alkyl, aryl, substituted aryl, hetaryl, and substituted hetaryl as defined herein.

“Aryl” - alone or in combination means phenyl or naphthyl optionally carbocyclic fused with a cycloalkyl of preferably 5-7, more preferably 5-6, ring members and/or optionally substituted with 1 to 3 groups or substituents of halo, hydroxy, alkoxy, alkylthio, alkylsulfinyl, alkylsulfonyl, acyloxy, aryloxy, heteroaryloxy, amino optionally mono- or di-substituted with alkyl, aryl or heteroaryl groups, amidino, urea optionally substituted with alkyl, aryl, heteroaryl or heterocyclyl groups, aminosulfonyl optionally N-mono- or N,N-di-substituted with alkyl, aryl or heteroaryl groups, alkylsulfonylamino, arylsulfonylamino,

heteroarylsulfonylamino, alkylcarbonylamino, arylcarbonylamino, heteroarylcarbonylamino, or the like.

“Substituted aryl” refers to aryl optionally substituted with one or more functional groups, *e.g.*, halogen, lower alkyl, lower alkoxy, alkylthio, acetylene, amino, amido, 5 carboxyl, hydroxyl, aryl, aryloxy, heterocycle, hetaryl, substituted hetaryl, nitro, cyano, thiol, sulfamido and the like.

“Heterocycle” refers to a saturated, unsaturated, or aromatic carbocyclic group having a single ring (*e.g.*, morpholino, pyridyl or furyl) or multiple condensed rings (*e.g.*, naphthpyridyl, quinoxalyl, quinolinyl, indolizinyll or benzo[b]thienyl) and having at least one 10 hetero atom, such as N, O or S, within the ring, which can optionally be unsubstituted or substituted with, *e.g.*, halogen, lower alkyl, lower alkoxy, alkylthio, acetylene, amino, amido, carboxyl, hydroxyl, aryl, aryloxy, heterocycle, hetaryl, substituted hetaryl, nitro, cyano, thiol, sulfamido and the like.

“Heteroaryl” - alone or in combination means a monocyclic aromatic ring structure 15 containing 5 or 6 ring atoms, or a bicyclic aromatic group having 8 to 10 atoms, containing one or more, preferably 1-4, more preferably 1-3, even more preferably 1-2, heteroatoms independently selected from the group O, S, and N, and optionally substituted with 1 to 3 groups or substituents of halo, hydroxy, alkoxy, alkylthio, alkylsulfinyl, alkylsulfonyl, acyloxy, aryloxy, heteroaryloxy, amino optionally mono- or di-substituted with alkyl, aryl or 20 heteroaryl groups, amidino, urea optionally substituted with alkyl, aryl, heteroaryl or heterocyclyl groups, aminosulfonyl optionally N-mono- or N,N-di-substituted with alkyl, aryl or heteroaryl groups, alkylsulfonylamino, arylsulfonylamino, heteroarylsulfonylamino, alkylcarbonylamino, arylcarbonylamino, heteroarylcarbonylamino, or the like. Heteroaryl is also intended to include oxidized S or N, such as sulfinyl, sulfonyl and N-oxide of a tertiary 25 ring nitrogen. A carbon or nitrogen atom is the point of attachment of the heteroaryl ring structure such that a stable aromatic ring is retained. Examples of heteroaryl groups are pyridinyl, pyridazinyl, pyrazinyl, quinazolinyl, purinyl, quinolinyl, isoquinolinyl, pyrimidinyl, pyrrolyl, oxazolyl, thiazolyl, thienyl, isoxazolyl, oxathiadiazolyl, isothiazolyl, tetrazolyl, imidazolyl, triazinyl, furanyl, benzofuryl, indolyl, benzothiazolyl, benzoxazolyl, and the like. 30 A substituted heteroaryl contains a substituent attached at an available carbon or nitrogen to produce a stable compound.

“Heterocyclyl” - alone or in combination means a non-aromatic cycloalkyl group having from 5 to 10 atoms in which from 1 to 3 carbon atoms in the ring are replaced by heteroatoms of O, S or N, and are optionally benzo fused or fused heteroaryl of 5-6 ring

members and/or are optionally substituted as in the case of cycloalkyl. Heterocycyl is also intended to include oxidized S or N, such as sulfinyl, sulfonyl and N-oxide of a tertiary ring nitrogen. The point of attachment is at a carbon or nitrogen atom. Examples of heterocycyl groups are tetrahydrofuranyl, dihydropyridinyl, piperidinyl, pyrrolidinyl, piperazinyl, 5 dihydrobenzofuranyl, dihydroindolyl, and the like. A substituted heterocycyl contains a substituent nitrogen attached at an available carbon or nitrogen to produce a stable compound.

"Substituted heteroaryl" refers to a heterocycle optionally mono or poly substituted with one or more functional groups, *e.g.*, halogen, lower alkyl, lower alkoxy, alkylthio, acetylene, amino, amido, carboxyl, hydroxyl, aryl, aryloxy, heterocycle, substituted 10 heterocycle, hetaryl, substituted hetaryl, nitro, cyano, thiol, sulfamido and the like.

"Aralkyl" refers to the group -R-Ar where Ar is an aryl group and R is lower alkyl or substituted lower alkyl group. Aryl groups can optionally be unsubstituted or substituted with, *e.g.*, halogen, lower alkyl, alkoxy, alkylthio, acetylene, amino, amido, carboxyl, hydroxyl, aryl, aryloxy, heterocycle, substituted heterocycle, hetaryl, substituted hetaryl, nitro, 15 cyano, thiol, sulfamido and the like.

"Heteroarylalkyl" refers to the group -R-HetAr where HetAr is an heteroaryl group and R lower alkyl or substituted lower alkyl. Heteroarylalkyl groups can optionally be unsubstituted or substituted with, *e.g.*, halogen, lower alkyl, substituted lower alkyl, alkoxy, alkylthio, acetylene, aryl, aryloxy, heterocycle, substituted heterocycle, hetaryl, substituted 20 hetaryl, nitro, cyano, thiol, sulfamido and the like.

"Cycloalkyl" refers to a divalent cyclic or polycyclic alkyl group containing 3 to 15 carbon atoms.

"Substituted cycloalkyl" refers to a cycloalkyl group comprising one or more substituents with, *e.g.*, halogen, lower alkyl, substituted lower alkyl, alkoxy, alkylthio, acetylene, aryl, aryloxy, heterocycle, substituted heterocycle, hetaryl, substituted hetaryl, 25 nitro, cyano, thiol, sulfamido and the like.

"Alkyl cycloalkyl" denotes the group -R-cycloalkyl where cycloalkyl is a cycloalkyl group and R is a lower alkyl or substituted lower alkyl. Cycloalkyl groups can optionally be unsubstituted or substituted with *e.g.* halogen, lower alkyl, lower alkoxy, alkylthio, acetylene, amino, amido, carboxyl, hydroxyl, aryl, aryloxy, heterocycle, substituted heterocycle, hetaryl, 30 substituted hetaryl, nitro, cyano, thiol, sulfamido and the like.

"Optional" and "optionally" mean that the subsequently described event or circumstance may or may not occur, and that the description includes instances where the event or circumstance occurs and instances in which it does not. For example, "optional

pharmaceutical excipients" indicates that a formulation so described may or may not include pharmaceutical excipients other than those specifically stated to be present, and that the formulation so described includes instances in which the optional excipients are present and instances in which they are not.

5 "Treating" and "treatment" refer to any treatment of a disease in a mammal, particularly a human, and include:

- (i) preventing the disease from occurring in a subject which may be predisposed to the disease but has not yet been diagnosed as having it;
- (ii) inhibiting the disease, i.e., arresting its development; or
- 10 (iii) relieving the disease, i.e., causing regression of the disease.

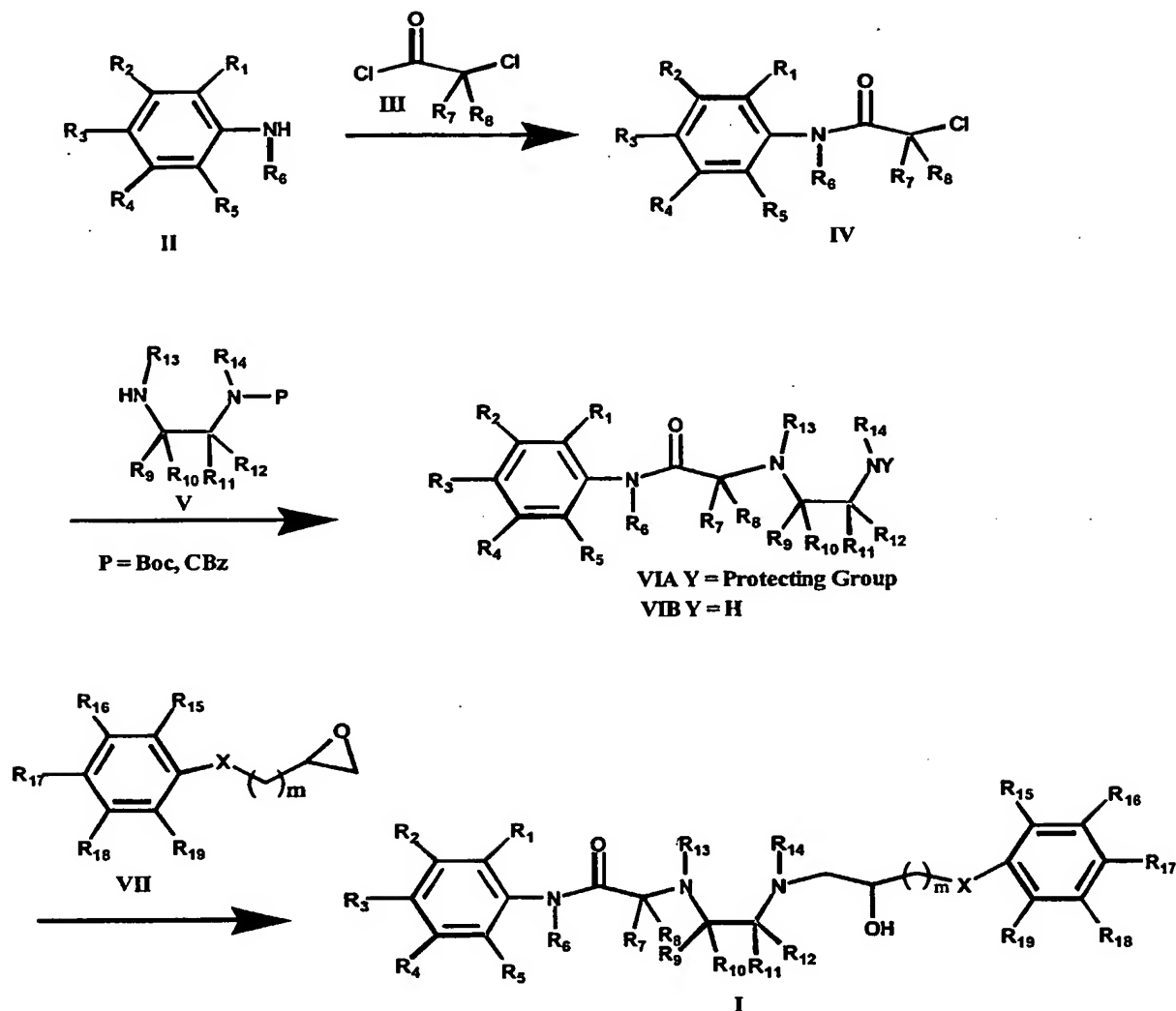
The compositions of this invention are useful for treating mammals in a therapy selected from the group consisting of protecting skeletal muscles against damage resulting from trauma, protecting skeletal muscles subsequent to muscle or systemic diseases such as intermittent claudication, to treat shock conditions, to preserve donor tissue and organs used  
15 in transplants, and to treat cardiovascular diseases including atrial and ventricular arrhythmias, Prinzmetal's (variant) angina, stable angina, and exercise induced angina, congestive heart disease, and myocardial infarction. The treatment is accomplished using a therapeutically effective amount of at least one compound of this invention and/or a pharmaceutically acceptable acid addition salt thereof in admixture with a pharmaceutically acceptable  
20 excipient.

Compounds falling within the scope of this invention include the optical isomers (+) and (-) and R- and S- isomers of the above-identified compounds and mixtures thereof. This invention includes the individual isomers and all possible mixtures thereof.

All of the aforementioned embodiments include the pharmaceutically acceptable acid  
25 addition salts thereof, particularly the mono- and dihydrochlorides, and mixtures thereof.

The compounds having the general formula I can be prepared as outlined in Schemes 1-5. A general synthesis of the compounds of this invention is outlined in Scheme 1.

## SCHEME 1

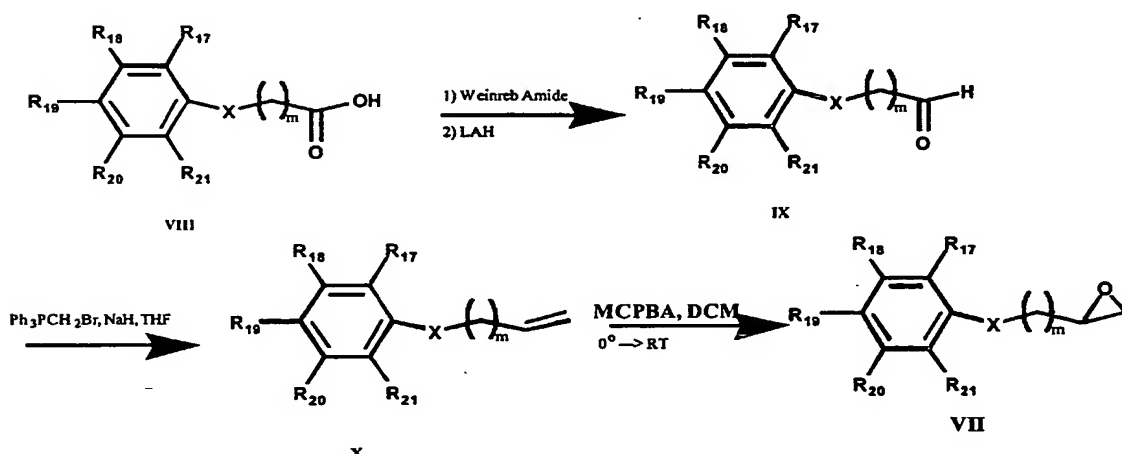


Compound **IV** can be prepared by N-acylation of substituted aniline **II** with 2-substituted chloroacetylchloride **III**. Compound **II** is available commercially or readily prepared through reduction of the corresponding nitrobenzene derivative (acid/ $SnCl_2$  or catalytic hydrogenation, see Advanced Organic Chemistry, Ed. J. March, (1992) A. Wiley-Interscience). Some examples of commercially available substituted aniline **II** include 2,6-dimethylaniline, 2,3-dimethylaniline, 2-methylaniline, 4-methylaniline, 4-methylaniline, 2,4-dichloroaniline, 3,4-dichloroaniline, 2,5-dichloroaniline, 2,4-dichloroaniline, 2-chloroaniline, 3-chloroaniline, 2,6-difluoroaniline, 2,5-difluoroaniline, 3,4-difluoroaniline, 2-fluoroaniline, 4-fluoroaniline, 3-fluoroaniline, 2-fluoro-6-chloroaniline, 4-fluoro-3-chloroaniline. Compound **VI** can be obtained by reacting compound **IV** with substituted ethylenediamine **V** through warming in an appropriate solvent (e.g. DMF, EtOH). Protection of the nitrogen of compound **V** is only

required when it is useful to control the regiochemistry of the addition of Compound V with compound IV.

In some cases, compound V can be obtained from commercial sources. Examples of commercially available compounds corresponding to compounds of general structure V include but are not limited to N,N'-dimethylethylenediamine and N,N'-diethylethylenediamine. Deprotection of compound VIA can be accomplished using the standard conditions (e.g. for Boc group use TFA, for CBZ and benzyl use hydrogenation). Compound I can be prepared by reacting compound VIB with epoxide VII through warming in an appropriate solvent (ethanol, DMF).

## SCHEME 2

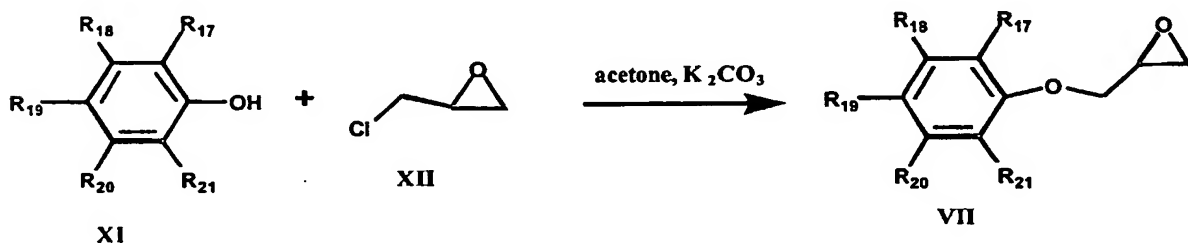


Epoxide VII (where  $x = \text{CH}_2$ ,  $m = 0$ ) can be prepared as outlined in Scheme 2. Epoxidation of substituted allylbenzene X using mCPBA or hydrogen peroxide can afford epoxide VII (G. Majetich, R. Hicks, G. Sun and P. McGill, (1998), 63, 2564-2573). Compound X in turn can be prepared by reacting aldehyde IX with methylenetriphenylphosphorane under Wittig conditions or Horner Emmons conditions [Advanced Organic Chemistry, Eds. J. March, (1992), Wiley-Interscience publication and S. Pine, G. Shen and H. Hoang, Synthesis, (1991), 1]. In some cases compound X can be obtained from commercial sources. Examples of commercially available compounds corresponding to the general structure X include (where  $m = 0$  and  $X = (\text{CH})_n$ ,  $n = 0$ ) 3-fluorostyrene, 4-fluorostyrene, 2-chlorostyrene, 3-chlorostyrene, 4-chlorostyrene, 2,6-dichlorostyrene, 3,4-dichlorostyrene and 3,4-dimethoxystyrene. Other examples of commercially available compounds with the general structure X wherein  $m = 0$  and  $X = (\text{CH})_n$ ,  $n = 1$ , include 4-methoxyallylbenzene, 2-hydroxyallylbenzene, 4,5-dimethoxyallylbenzene, 2-methylallylbenzene safrole and 1-



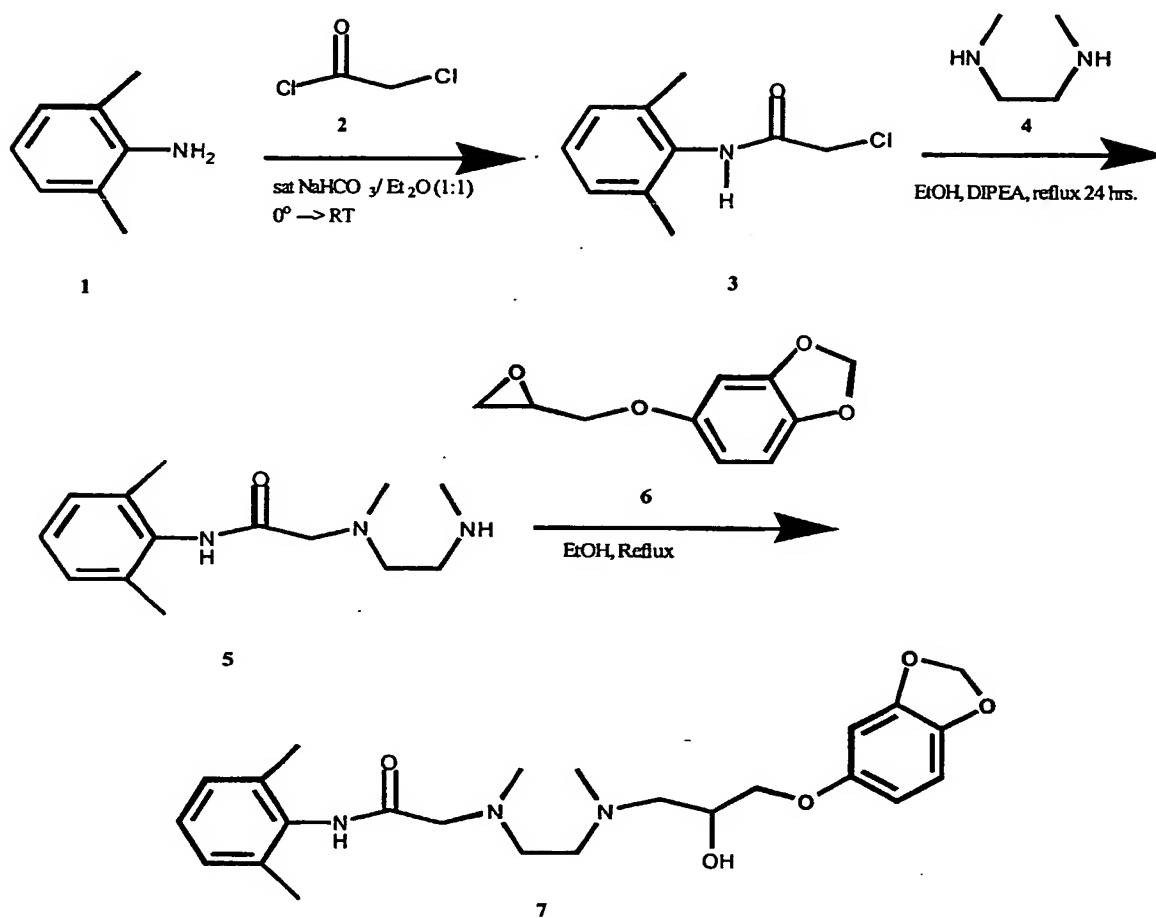
allylnaphthalene. The aldehyde IX can be prepared by coupling substituted phenylacetic acid VIII with N-methyl,O-methoxyamine followed by LAH reduction of the resulting Weinreb amide amide [see S. M. Weinreb et al Tetrahedron Lett. (1981) p. 3815-3818 and B. Fraser-Reid Tetrahedron (1990) p. 185-200]. Compound VIII can be obtained from commercial sources. Examples of commercially available compounds of compounds with the general structure VIII include 2-chlorophenylacetic acid, 2-fluorophenylacetic acid, 2,4-dichlorophenylacetic acid, 2-fluoro, 6-chlorophenylacetic acid, 2,6-dichlorophenylacetic acid, 3,4-dichlorophenylacetic acid, 2-trifluoromethylphenylacetic acid, 2-methylphenyl acetic acid, 3-fluorophenyl acetic acid, 3-chlorophenyl acetic acid, 4-fluorophenyl acetic acid and 4-chlorophenyl acetic acid. Epoxide VII can be prepared as outlined in Scheme 3. Reaction of phenol XI with excess epichlorohydrin through warming in acetone can afford epoxide VII, wherein  $x = O$ ,  $m = 1$ . Compound XI can be obtained from commercial sources. Example of commercially available compounds corresponding to the general structure XI include 2-chlorophenol, 2-fluorophenol, 2-methoxyphenol, 2-methylphenol, sesamol, 2,6-dichlorophenol, 3,5-dichlorophenol, 2,6-difluorophenol, 2,4-difluorophenol, 5-indanol, 3-chloro-4-fluorophenol, 2-chloro-4-fluorophenol and 5,6,7,8-tetrahydro-2-naphthol.

### SCHEME 3

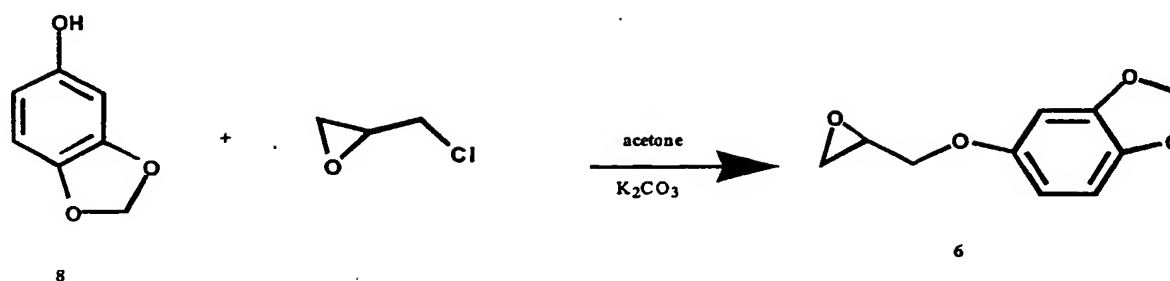


A specific example of the preparation of a compound from this invention is disclosed in Scheme 4 to further illustrate how to prepare the compounds of this invention. In particular, 2,6-dichloroaniline was acylated with 2-chloroacetyl chloride 2 using saturated bicarbonate and ether (1:1) as base and co-solvent, respectively to afford the chloroacetamide derivative 3. Further reaction of compound 3 with N,N'-dimethylethylenediamine afforded compound 5 through warming in ethanol. Reaction of compound 5 with epoxide 6 by warming both components in ethanol at reflux afforded N,N'-dimethylethylenediamine derivative 7.

Epoxide 6 was prepared by reacting compound 8 with excess epichlorohydrine in acetone as illustrated in Scheme 5.

**SCHEME 4**

## SCHEME 5



The acid addition salts of the compounds of this invention may be converted to the  
5 corresponding free base by treating with a suitable base, such as potassium carbonate or sodium hydroxide, typically in the presence of aqueous solvent, and at a temperature of between about 0 degrees C and 100 degrees C. The free base form is isolated by conventional means, such as extraction with an organic solvent.

Salts of the compounds of this invention may be interchanged by taking advantage of  
10 differential solubilities and volatilities, or by treating with the appropriately loaded ion exchange resin. This conversion is carried out at a temperature between about 0°C and the boiling point of the solvent being used as the medium for the procedure. Administration of the active compounds and salts described herein can be via any of the accepted modes of administration for therapeutic agents. These methods include oral,  
15 parenteral, transdermal, subcutaneous and other systemic modes. The preferred method of administration is oral, except in those cases where the subject is unable to ingest, by himself, any medication. In those instances it may be necessary to administer the composition parenterally.

Depending on the intended mode, the compositions may be in the form of solid, semi-  
20 solid or liquid dosage forms, such as, for example, tablets, suppositories, pills, capsules, powders, liquids, suspensions, or the like, preferably in unit dosage forms suitable for single administration of precise dosages. The compositions may include one or more conventional pharmaceutical excipients and at least one active compound of this invention or the pharmaceutically acceptable salts thereof and, in addition, may include other medicinal  
25 agents, pharmaceutical agents, carriers, adjuvants, diluents, etc.

The amount of active compound administered will, of course, be dependent on the subject being treated, the subject's weight, the severity of the affliction, the manner of

administration and the judgment of the prescribing physician. However, an effective dosage is in the range of 0.1-30 mg/kg/day, preferably 0.5-20 mg/kg/day. For an average 70 kg human, this would amount to 7-2100 mg per day, or preferably 35-1400 mg/day. Since many of the effects of the compounds herein (protect skeletal muscles against damage  
5 resulting from trauma; protect skeletal muscles subsequent to muscle or systemic diseases such as intermittent claudication; treat shock conditions; preserve donor tissue and organs used in transplants; and treat cardiovascular diseases including atrial and ventricular arrhythmias, Prinzmetal's (variant) angina, stable angina, exercise induced angina, congestive heart disease, and myocardial infarction) are achieved through a similar mechanism (partial  
10 fatty acid oxidation inhibition) dosages (and forms of administration) are all generally within the same general and preferred ranges for all these utilities.

For solid compositions, conventional non-toxic solid include, for example, pharmaceutical grades of mannitol, lactose, starch, magnesium stearate, sodium saccharin, talcum, cellulose, glucose, sucrose, magnesium carbonate, and the like may be used. The  
15 active compound as defined above may be formulated as suppositories using, for example, polyalkylene glycols, for example, propylene glycol, as the carrier. Liquid pharmaceutically administrable compositions can, for example, be prepared by dissolving, dispersing, etc. an active compound as defined above and optional pharmaceutical adjuvants in a excipient, such as, for example, water, saline, aqueous dextrose, glycerol, ethanol, and the like, to thereby  
20 form a solution or suspension. If desired, the pharmaceutical composition to be administered may also contain minor amounts of nontoxic auxiliary substances such as wetting or emulsifying agents, pH buffering agents and the like, for example, sodium acetate, sorbitan monolaurate, triethanolamine sodium acetate, triethanolamine oleate, etc. Actual methods of preparing such dosage forms are known, or will be apparent, to those skilled in this art; for  
25 example, see Remington's Pharmaceutical Sciences, Mack Publishing Company, Easton, Pennsylvania, 15th Edition, 1975. The composition or formulation to be administered will, in any event, contain a quantity of the active compound(s), a therapeutically effective amount, i.e. in an amount effective to alleviate the symptoms of the subject being treated. For oral administration, a pharmaceutically acceptable non-toxic composition is formed by the  
30 incorporation of any of the normally employed excipients, such as, for example pharmaceutical grades of mannitol, lactose, starch, magnesium stearate, sodium saccharin, talcum, cellulose, glucose, sucrose, magnesium, carbonate, and the like. Such compositions take the form of solutions, suspensions, tablets, pills, capsules, powders, sustained release

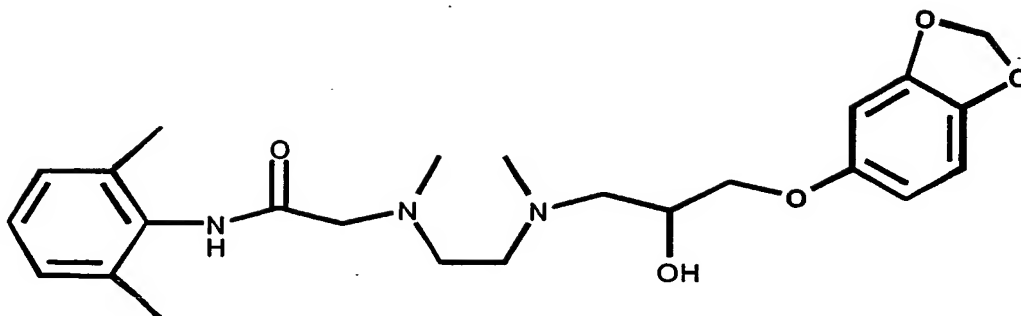
formulations and the like. Such compositions may contain 10%-95% active ingredient, preferably 1-70%.

Parenteral administration is generally characterized by injection, either subcutaneously, intramuscularly or intravenously. Injectables can be prepared in conventional forms, either as liquid solutions or suspensions, solid forms suitable for solution or suspension in liquid prior to injection, or as emulsions. Suitable excipients are, for example, water, saline, dextrose, glycerol, ethanol or the like. In addition, if desired, the pharmaceutical compositions to be administered may also contain minor amounts of non-toxic auxiliary substances such as wetting or emulsifying agents, pH buffering agents and the like, such as for example, sodium acetate, sorbitan monolaurate, triethanolamine oleate, etc.

A more recently devised approach for parenteral administration employs the implantation of a slow-release or sustained-release system, such that a constant level of dosage is maintained. See, e.g., U.S. Pat. No. 3,710,795, which is incorporated herein by reference. In another recent approach, the compositions of this invention can be administered orally in a sustained release dosage form using the compositions and/or methods disclosed in U.S. Patent Application Serial No. 09/321,522, filed on May 27, 1999, the specification of which is incorporated herein by reference.

It is within the scope of this invention to administer one or more compounds of this invention to a mammal, and preferably to a human by other known routes of pharmaceutical dosage form administration including, but not limited to by bolus, intravenously, transdermally, through inhalation, sub-cutaneously, or any other therapeutic agent administration method or route known to one skilled in the art.

The following Examples are representative of the invention, but are not to be construed as limiting the scope of the claims.

**Example 1**

2-((2-((3-(2H-benzo[d][1,3-dioxolen-5-yloxy)-2-hydroxypropyl)methylamino)ethyl)-methylamino)-N-(2,6-dimethylphenyl)acetamide (7).

5

**Part A.****Synthesis of N-(2,6-dimethylphenyl)-2-chloroacetamide (3).**

2,6-dimethylaniline (9.8 g, 81.2 mmol) was dissolved in ether (100 mL) and saturated aqueous NaHCO<sub>3</sub> (100 mL) and the reaction mixture was cooled in an ice/water bath. To the cold solution was added chloroacetyl chloride 2 (9.17 g, 81.2 mmol) dropwise over a period of 2 h. The mixture was allowed to warm to RT over 14 h. The mixture was diluted with 100 mL ether and the organic layer was separated, dried over MgSO<sub>4</sub>, filtered and concentrated to afford compound 3 as a white solid.

**Part B.****Synthesis of N-(2,6-dimethylphenyl)-2-piperazinylacetamide (5).**

To a solution of compound 3 in 100 mL EtOH (5 g, 25.2 mmol) in ethanol (100 mL) was added compound 4 (2.1 g, 25.0 mmol) and N,N-diisopropylethylamine (3.2 g, 25.2 mmol). The reaction mixture was refluxed for 24 h. The mixture was concentrated *in vacuo* and the residue was purified by column chromatography (10:1, DCM:MeOH) to afford compound 5.

**Part C.****Synthesis of 5-(oxiran-2-ylmethoxy)-2H-benzo[d][1,3-dioxolane (6).**

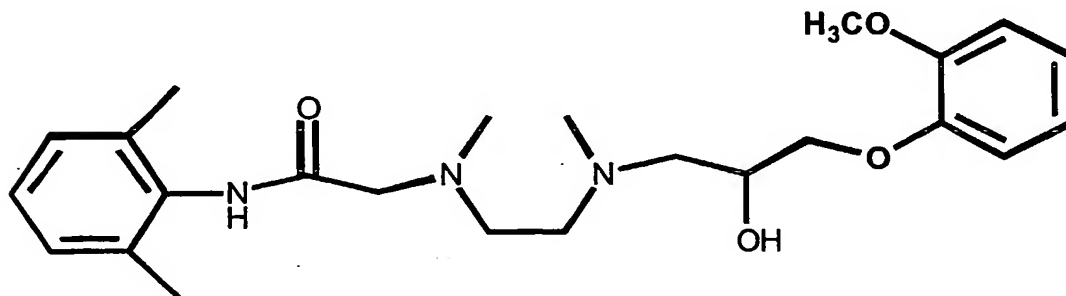
To a solution of potassium carbonate (2.0 g, 14.5 mmol) in acetone 50 mL was added epichlorohydrin (3.2 g, 35 mmol) and phenol 8 (1.0 g, 7.2 mmol). The mixture was heated at reflux for 48 h. The mixture was then cooled to RT, filtered and concentrated to a brown oil.

The oil was purified using column chromatography (Hex:EtOAc, 3:1) to afford 6.

**Part D.**

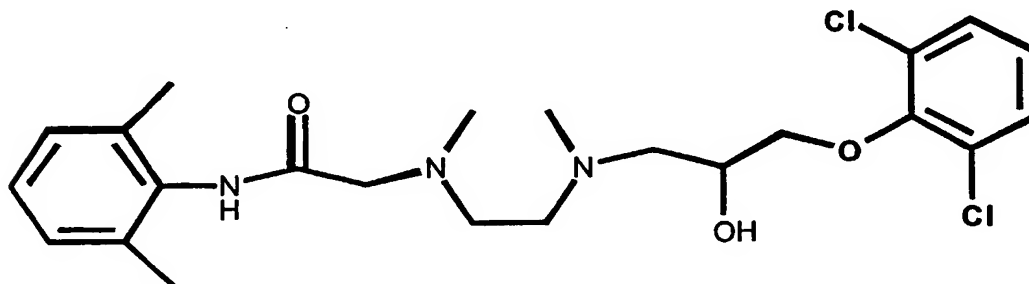
Synthesis of 2-((2-[(3-(2H-benzo[d]1,3-dioxolen-5-yloxy)-2-hydroxypropyl)methylamino]ethyl)methylamino)-N-(2,6-dimethylphenyl)acetamide (7).

To a solution of compound 5 (0.2 g, 0.8 mmol) in ethanol (5 mL) was added compound 6 (0.17 g, 0.88 mmol). The reaction mixture was heated at reflux for 24 h. The mixture was concentrated *in vacuo*, and the residue was purified by using Prep. TLC (15:1, DCM:MeOH) to afford compound 7: Mass spectrum (M+1) = 444.36.



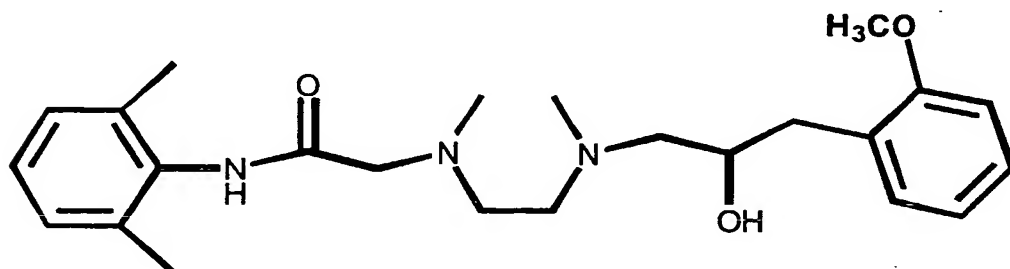
N-(2,6-dimethylphenyl)-2-((2-[(2-hydroxy-3-(2-methoxyphenoxy)propyl)methylamino]ethyl)methylamino)acetamide (9).

Compound 9 was prepared in the manner of compound 7 using the 2-methoxy-1-(oxiran-2-ylmethoxy)benzene in part C to afford compound 9: Mass spectrum (M+1) = 430.37.



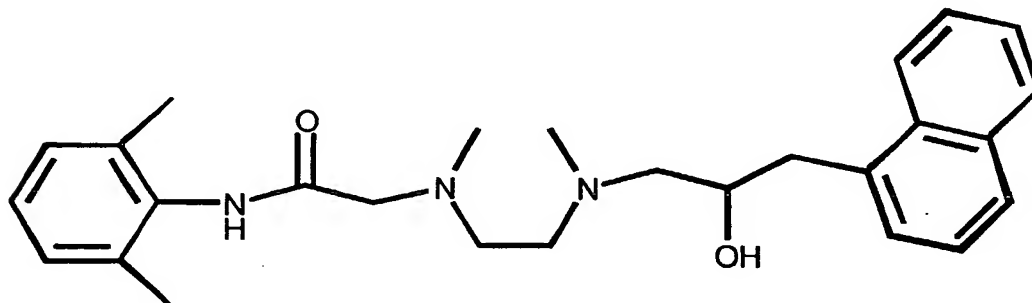
**2-[(2-{[3-(2,6-dichlorophenoxy)-2-hydroxypropyl]methylamino}ethyl)methylamino]-N-(2,6-dimethylphenyl)acetamide(10)**

Compound 10 was prepared in the manner of compound 7 using 1,3-dichloro-2-(oxiran-2-ylmethoxy)benzene in part C to afford compound 10: Mass spectrum (M+1) = 468.29



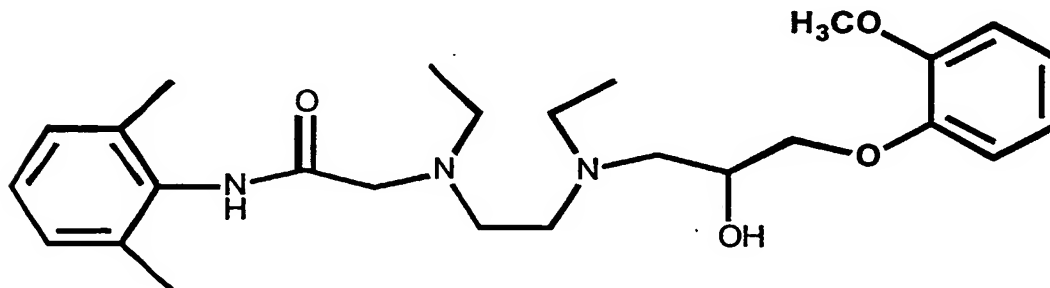
**N-(2,6-dimethylphenyl)-2-[(2-{[2-hydroxy-3-(2-methoxyphenyl)propyl]methylamino}ethyl)methylamino]acetamide (11).**

Compound 11 was prepared in the manner of compound 7 using 2-methoxy-1-(oxiran-2-ylmethyl)benzene in part C to afford compound 11: Mass spectrum (M+1) = 414.35.



**N-(2,6-dimethylphenyl)-2-[(2-{[2-hydroxy-3-naphthylpropyl]methylamino}ethyl)methylamino]acetamide (12)**

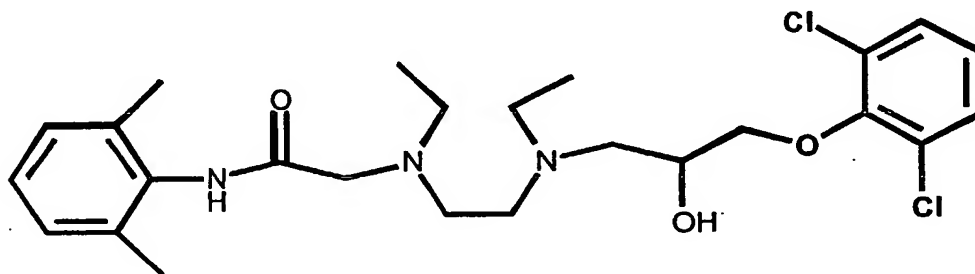
Compound 12 was prepared in the manner of compound 7 using 2-(naphthylmethyl)oxirane in part C to afford compound 12: Mass spectrum (M+1) = 434.37.





**N-(2,6-dimethylphenyl)-2-[ethyl(2-{ethyl[2-hydroxy-3-(2-methoxyphenoxy)propyl]amino}ethyl)amino]acetamide (13).**

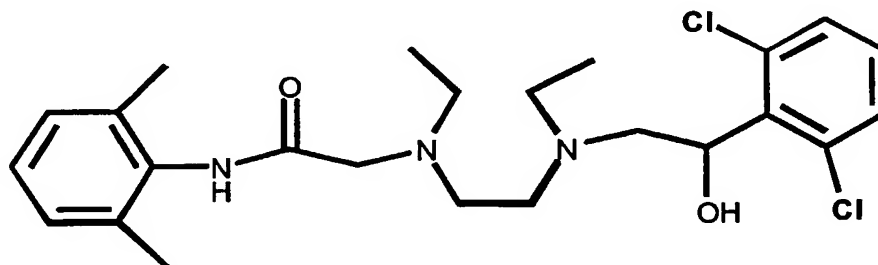
Compound 13 was prepared in the manner of compound 7 using 2-methoxy-1-(oxiran-2-ylmethoxy)benzene and N-(2,6-dimethylphenyl)-2-{ethyl[2-(ethylamino)ethyl]amino}acetamide in part C to afford compound 13: Mass spectrum (M+1) = 458.42.



**2-[(2-{[3-(2,6-dichlorophenoxy)-2-hydroxypropyl]ethylamino}ethyl)ethylamino]-N-(2,6-dimethylphenyl)acetamide (14)**

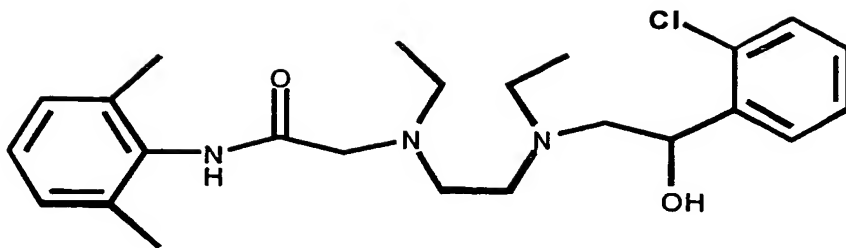
10

Compound 14 was prepared in the manner of compound 7 using 1,3-dichloro-2-(oxiran-2-ylmethoxy)benzene and N-(2,6-dimethylphenyl)-2-{ethyl[2-(ethylamino)ethyl]amino}acetamide in part C to afford compound 14: Mass spectrum (M+1) = 496.34.



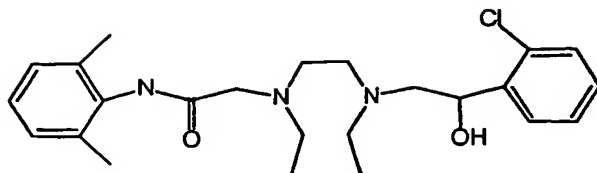
**2-[(2-{[2-(2,6-dichlorophenyl)-2-hydroxyethyl]ethylamino}ethyl)ethylamino]-N-(2,6-dimethylphenyl)acetamide (15).**

Compound 15 was prepared in the manner of compound 7 using 2-(2,6-dichlorophenyl)oxirane and N-(2,6-dimethylphenyl)-2-{ethyl[2-(ethylamino)ethyl]amino}acetamide in part C to afford compound 15: Mass spectrum (M+1) = 466.41.



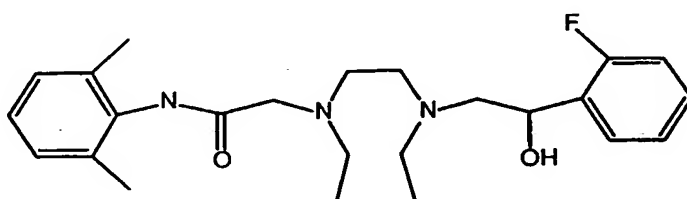
**N-(2,6-dimethylphenyl)-2-[(2-{[2-(2-chlorophenyl)-2-hydroxyethyl] ethylamino} ethyl) ethylamino]acetamide (16)**

- 5 Compound 16 was prepared in the manner of compound 7 using 2-(2-chlorophenyl)oxirane and N-(2,6-dimethylphenyl)-2-{ethyl[2-(ethylamino)ethyl]amino}acetamide in part C to afford compound 16: Mass spectrum (M+1) = 432.37.



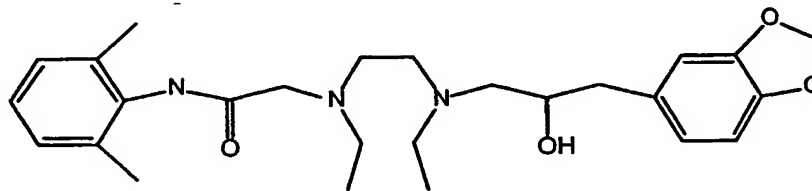
N-(2,6-dimethylphenyl)-2-[(2-[[2-(2-chlorophenyl)-2-hydroxyethyl]ethylamino]ethyl)ethylamino]acetamide(17)

Compound 17 was prepared in the manner of compound 7 using 2-(2-chlorophenyl)oxirane and N-(2,6-dimethylphenyl)-2-{ethyl[2-(ethylamino)ethyl]amino}acetamide in part C to afford compound 17:



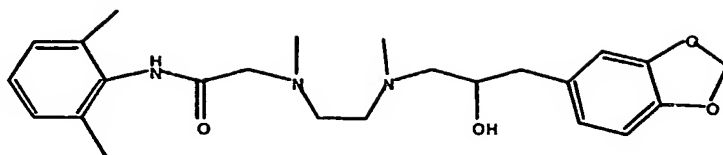
N-(2,6-dimethylphenyl)-2-[ethyl(2-{ethyl[2-(2-fluorophenyl)-2-hydroxyethyl]amino}ethyl)amino]acetamide (18)

Compound 18 was prepared in the manner of compound 7 using 2-(2-fluorophenyl)oxirane and N-(2,6-dimethylphenyl)-2-{ethyl[2-(ethylamino)ethyl]amino}acetamide in part C to afford compound 18:



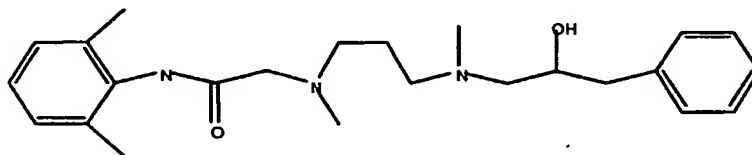
2-({2-[(3-(2H-benzo[d][1,3-dioxolen-5-yl)-2-hydroxypropyl]ethylamino]ethyl}ethylamino)-N-(2,6-dimethylphenyl)acetamide(19)

Compound 19 was prepared in the manner of compound 7 using 5-(oxiran-2-ylmethoxy)-2H-benzod[1,3-dioxolane and N-(2,6-dimethylphenyl)-2-{ethyl[2-(ethylamino)ethyl]amino}acetamide in part C to afford compound 19:



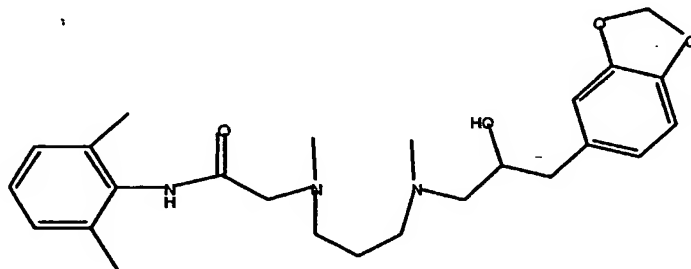
2-({2-[(3-(2H-benzo[d][1,3-dioxolen-5-yl)-2-hydroxypropyl]ethylamino)ethyl]ethylamino}-N-(2,6-dimethylphenyl)acetamide (20)

Compound 20 was prepared in the manner of compound 7 using the 5-(oxiran-2-ylmethoxy)-2H-benzo[d][1,3-dioxolane in part C to afford compound 20



N-(2,6-dimethylphenyl)-2-({3-[(2-hydroxy-3-phenylpropyl)methylamino]propyl}methylamino)acetamide (21)

Compound 21 was prepared in the manner of compound 7 using N-(2,6-dimethylphenyl)-2-({methyl[3-(methylamino)propyl]amino}acetamide and 2-(2-phenylethyl)oxirane in part C to afford compound 21



2-({3-[(3-(2H-benzo[d][1,3-dioxolen-5-yl)-2-hydroxypropyl)methylamino]propyl}methylamino)-N-(2,6-dimethylphenyl)acetamide (22)

Compound 22 was prepared in the manner of compound 7 using N-(2,6-dimethylphenyl)-2-({methyl[3-(methylamino)propyl]amino}acetamide and 5-(oxiran-2-ylmethoxy)-2H-benzo[d][1,3-dioxolane in part C to afford compound 22

**Example 2****Mitochondrial Assays**

Rat heart mitochondria were isolated by the method of Nedergard and Cannon (Methods in Enzymol. 55, 3, 1979).

- 5 **Palmitoyl CoA oxidation** – The Palmitoyl CoA oxidation was carried out in a total volume of 100 microliters containing the following agents: 110 mM KCl, 33 mM Tris buffer at pH 8, 2 mM KPi, 2 mM MgCl<sub>2</sub>, 0.1 mM EDTA, 14.7 microM defatted BSA, 0.5 mM malic acid, 13 mM carnitine, 1 mM ADP, 52 micrograms of mitochondrial protein, and 16 microM 1-C14 palmitoyl CoA (Sp. Activity 60 mCi/mmol; 20 microCi/ml, using 5 microliters per assay).
- 10 The compounds of this invention were added in a DMSO solution at the following concentrations: 100 microM, 30 microM, and 3 microM. In each assay, a DMSO control was used. After 15 min at 30 oC, the enzymatic reaction was centrifuged (20,000 g for 1 min), and 70 microliters of the supernatant was added to an activated reverse phase silicic acid column (approximately 0.5 ml of silicic acid). The column was eluted with 2 ml of water,
- 15 and 0.5 ml of the eluent was used for scintillation counting to determine the amount of C<sup>14</sup> trapped as C<sup>14</sup> bicarbonate ion. The data are presented as % activity of control.

**Table 1.**

**Inhibition of mitochondrial fatty acid oxidation using palmitoyl CoA as substrate - % of Control at 3 concentrations.**

Compound #	100 $\mu$ M	30 $\mu$ M	3 $\mu$ M
Ranolazine	75%	90%	--
7	--	--	--
9	8.83%	--	--
10	23%	--	--
11	8%	--	--
12	26.5%	--	--
13	67.8%	--	--
14	97.1%	--	--
15	45.5	--	--
16	--		
17	34.3		
18	54.8		
19	26		
20	--		
21	--		
22	12.5	--	--

**Example 3**

**Palmitoyl Carnitine Oxidation** – The Palmitoyl carnitine oxidation was carried out in a total volume of 100 microliters containing the following agents: 110 mM KCl, 33 mM Tris buffer at pH 8, 2 mM KPi, 2 mM MgCl<sub>2</sub>, 0.1 mM EDTA, 0.1 mg/ml of defatted BSA, 0.5 mM malic acid, 3 mM ADP, 52 micrograms of mitochondrial protein, and 43 microM 1-C<sup>14</sup> palmitoyl carnitine (Sp. Activity 60 mCi/mmol; 20 microCi/ml, using 5 microliters per assay). The compounds of this invention were added in a DMSO solution at the following concentrations: 100 microM, 30 microM, and 3 microM. In each assay, a DMSO control was used. After 15 min at 30 °C, the enzymatic reaction was centrifuged (20,000 g for 1 min), and 70 microliters of the supernatant was added to an activated reverse phase silicic acid column (approximately 0.5 ml of silicic acid). The column was eluted with 2 ml of water, and 0.5 ml of the eluent was used for scintillation counting to determine the amount of C<sup>14</sup> trapped as C<sup>14</sup> bicarbonate ion. The data are presented as % activity of control.

**Table 2.**

Inhibition of mitochondrial fatty acid oxidation using palmitoyl carnitine as substrate - % of Control at 3 concentrations.

Compound #	100 $\mu$ M	30 $\mu$ M	3 $\mu$ M
Ranolazine	63%	98%	--
7	--	--	--
9	--	--	--
10	--	--	--
11	--	--	--
12	--	--	--
13	--	--	--
14	--	--	--
15	--	--	--
16			
17			
18			
19	97.1		
20	98.7		
21	4.9		
22	97	--	--

#### Example 4

**Metabolic Stability:** As a measure of metabolic stability the compounds of this invention were incubated with human liver S-9 microsomal fractions. After, 30 minutes at 37 C, the amount of parent drug remaining was determined using LC-mass spec. The response factors for each compound was determined by establishing a standard curve and using an internal standard during the analysis of the samples. An average of five experiments for percentage of ranolazine remaining at the 30 minute time point is 57%. The compounds of this invention were assayed as described in the protocol below and the percentage of parent remaining was divided by the average % of ranolazine remaining (57%) affording a metabolic stability factor.

5

10 A compound with a stability number greater than 1.2 has a better stability than ranolazine in the liver S-9 assay. A compound with a stability number between 1.2 and 0.8 has an equivalent stability in the liver S-9 assay. A compound with a stability number less than 0.8 is less stable than ranolazine in the liver S-9 assay.

The purpose of this experiment is to compare the percentages remaining for compounds of this invention with the percentage remaining for ranolazine after 30 minutes of incubation with human liver S9 fractions.

15

#### Reagents:

The following reagents were used; Potassium phosphate, 0.5M pH 7.4. (incubation buffer), kept at room temperature; 0.05M MgCl<sub>2</sub> kept at 4°C; β-Nicotinamide adenine dinucleotide phosphate, tetrasodium salt, reduced form (NADPH), 0.02M solution in water (~16.6mg/mL) from Sigma Lot # 79H7044 prepared on day of use. 1mM of ranolazine or Compounds 7, 9, and 10-13 in ACN further diluted to obtain 100μM in 10% ACN; Human S9 stock: 20mg/mL from Gentest Lot 3.

20

**Procedure:**

Incubation mixtures were prepared as follows:

**Table 3**

Component	Volume per 0.25mL of Incubation Mixture	Final concentration
100μM CVT compounds	25μL	10 μM
MgCl <sub>2</sub>	25μL	0.005 M
NADPH	25μL	0.002 M
S9	25μL	2 mg/mL
Incubation Buffer	25μL	0.05 M
Water	125μL	----

5 \* 1% organic solvent (acetonitrile) was used in incubation mixture. Generally, 30 incubates were prepared at a time by pre-mixing 0.75 mL of MgCl<sub>2</sub>, 0.75 mL of incubation buffer, 0.75 mL of NADPH, 3.75 mL of water. Then pipette 200 μL/incubate, add 25 μL of compound being tested, mix, and initiate reaction by addition of S-9.

10 Combine all components with incubation buffer and re-pipette 200 μL/tube + 25μL of the compound being tested along with 25μL of S-9.

After 5 min of pre-incubation at 37°C, at 0 and 30min after starting the reaction, a 50 μl aliquot of the incubation mixture was removed and added to 100 μL of 9:1 acetonitrile: methanol containing the internal standard.

15 The mixture was centrifuged and a 100 μL aliquot of the supernatant was diluted in 1mL of solvent C (0.1% Formic Acid in water). Then samples were analyzed for change between the ratio of compound to internal standard at time zero and 30 minutes by LC/MS (injected 10 μL).

**Analytical and Data Calculations:**

20 Samples were analyzed for the starting compounds and potential metabolite/s by LC/MS using an internal standard on a Micromass platform mass spec with a Keystone Inc. BDS ODS-C18 column with a flow rate of 0.25 ml/min. Following the above procedure resulted in the following relative stability factors as compared to ranolazine for the compounds of this invention as illustrated in Table 4.

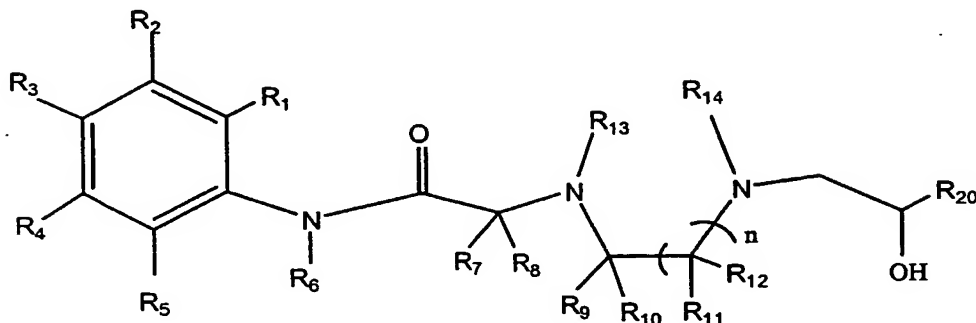


**Table 4**

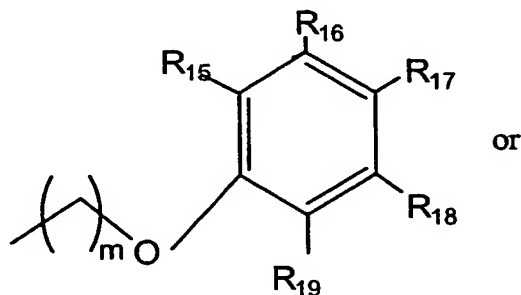
Compound #	Liver S-9 stability factor
Ranolazine	1.0
7	1.51
17	0.01
20	1.59
21	0.08
22	1.58

What we claim is:

1. A substituted piperazine compound having the following formula:

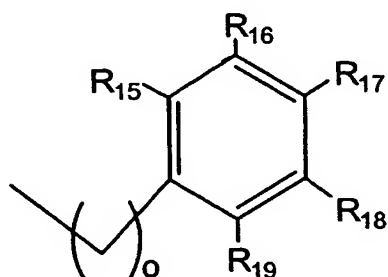


- 5 wherein  $R_{20}$  is selected from the group consisting of



or

or



wherein  $m = 1$  or  $2$ ,  $n = 1$  or  $2$ ,  $o = 0$  or  $1$  or  $2$ ;

- $R_1$ ,  $R_2$ ,  $R_3$ ,  $R_4$  and  $R_5$  are each independently selected from the group consisting of hydrogen, halo,  $\text{NO}_2$ ,  $\text{CF}_3$ ,  $\text{CN}$ ,  $\text{OR}_{23}$ ,  $\text{SR}_{23}$ ,  $\text{N(R}_{23})_2$ ,  $\text{S(O)R}_{22}$ ,  $\text{SO}_2\text{R}_{22}$ ,  $\text{SO}_2\text{N(R}_{23})_2$ ,  $\text{NR}_{23}\text{CO}_2\text{R}_{22}$ ,  $\text{NR}_{23}\text{CON(R}_{23})_2$ ,  $\text{COR}_{23}$ ,  $\text{CO}_2\text{R}_{23}$ ,  $\text{CON(R}_{23})_2$ ,  $\text{NR}_{23}\text{SO}_2\text{R}_{22}$ ,  $\text{C}_{1-15}$  alkyl,  $\text{C}_{2-15}$  alkenyl,  $\text{C}_{2-15}$  alkynyl, heterocyclyl, aryl, and heteroaryl, wherein the alkyl and aryl

substituent are optionally substituted with 1 substituent selected from the group consisting of halo, NO<sub>2</sub>, CF<sub>3</sub>, CN, OR<sub>23</sub>, SR<sub>23</sub>, N(R<sub>23</sub>)<sub>2</sub>, S(O)R<sub>22</sub>, and SO<sub>2</sub>R<sub>22</sub>;

R<sub>6</sub>, R<sub>7</sub> and R<sub>8</sub> each independently selected from the group consisting of hydrogen or C<sub>1-15</sub> alkyl;

5 R<sub>9</sub>, R<sub>10</sub>, R<sub>11</sub>, and R<sub>12</sub> are each independently selected from the group consisting of hydrogen and lower alkyl, or R<sub>9</sub> and R<sub>10</sub> may together form a carbonyl, or R<sub>11</sub> and R<sub>12</sub> may together form -(CH<sub>2</sub>)<sub>P</sub> where P is 2-6 or carbonyl;

R<sub>13</sub> and R<sub>14</sub> are each independently selected from hydrogen and lower alkyl;

10 R<sub>15</sub>, R<sub>16</sub>, R<sub>17</sub>, R<sub>18</sub>, and R<sub>19</sub> are each independently selected from the group consisting of hydrogen, halo, NO<sub>2</sub>, CF<sub>3</sub>, CN, OR<sub>23</sub>, SR<sub>23</sub>, N(R<sub>23</sub>)<sub>2</sub>, S(O)R<sub>22</sub>, SO<sub>2</sub>R<sub>22</sub>, SO<sub>2</sub>N(R<sub>23</sub>)<sub>2</sub>, NR<sub>23</sub>CO<sub>2</sub>R<sub>22</sub>, NR<sub>23</sub>CON(R<sub>23</sub>)<sub>2</sub>, COR<sub>23</sub>, CO<sub>2</sub>R<sub>23</sub>, CON(R<sub>23</sub>)<sub>2</sub>, NR<sub>23</sub>SO<sub>2</sub>R<sub>22</sub>, C<sub>1-15</sub> alkyl, C<sub>2-15</sub> alkenyl, C<sub>2-15</sub> alkynyl, heterocyclyl, aryl, and heteroaryl, wherein the alkyl and aryl substituent are optionally substituted with 1 substituent selected from the group consisting of halo, NO<sub>2</sub>, CF<sub>3</sub>, CN, OR<sub>23</sub>, SR<sub>23</sub>, N(R<sub>23</sub>)<sub>2</sub>, S(O)R<sub>22</sub>, and SO<sub>2</sub>R<sub>22</sub> and wherein two adjacent  
15 substituents selected from the group consisting of R<sub>15</sub>, R<sub>16</sub>, R<sub>17</sub>, R<sub>18</sub>, and R<sub>19</sub> may together form a ring having from 3 to 6 carbon atoms wherein from 0 to 3 of the carbon atoms may be substituted with an oxygen atom;

R<sub>22</sub> is selected from the group consisting of C<sub>1-15</sub> alkyl, aryl, or heteroaryl, wherein the alkyl and aryl substituents are optionally substituted with 1 substituent selected from the  
20 group consisting of halo, alkyl, monoalkylamino, dialkylamino, alkyl amide, aryl amide, heteroaryl amide, CN, O-C<sub>1-6</sub> alkyl, CF<sub>3</sub>, or heteroaryl; and

R<sub>23</sub> is selected from the group consisting of H, C<sub>1-15</sub> alkyl, aryl, or heteroaryl, wherein the alkyl and aryl substituents are optionally substituted with 1 substituent selected from the group consisting of halo, alkyl, mono- or dialkylamino, alkyl, CN, -O-C<sub>1-6</sub> alkyl, or CF<sub>3</sub>.

25 2. A compound of claim 1 wherein R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, R<sub>4</sub> and R<sub>5</sub> are each independently selected from the group consisting of hydrogen, halo, CF<sub>3</sub>, CN, OR<sub>23</sub>, SR<sub>23</sub>, N(R<sub>23</sub>)<sub>2</sub>, SO<sub>2</sub>N(R<sub>23</sub>)<sub>2</sub>, CO<sub>2</sub>R<sub>23</sub>, CON(R<sub>23</sub>)<sub>2</sub>, C<sub>1-8</sub> alkyl, C<sub>2-8</sub> alkenyl, C<sub>2-8</sub> alkynyl heterocyclyl, aryl, or heteroaryl, wherein the alkyl and aryl substituents are optionally substituted with 1 substituent selected from the group consisting of halo, NO<sub>2</sub>, CF<sub>3</sub>, CN, OR<sub>23</sub>, SR<sub>23</sub>, N(R<sub>23</sub>)<sub>2</sub>, and S(O)R<sub>22</sub>,  
30 and SO<sub>2</sub>R<sub>22</sub>;

R<sub>6</sub>, R<sub>7</sub> and R<sub>8</sub> are each independently selected from the group consisting of hydrogen or C<sub>1-8</sub> alkyl; and

R<sub>15</sub>, R<sub>16</sub>, R<sub>17</sub>, R<sub>18</sub>, and R<sub>19</sub> are each independently selected from the group consisting of hydrogen, halo, NO<sub>2</sub>, CF<sub>3</sub>, CN, OR<sub>23</sub>, SR<sub>23</sub>, N(R<sub>23</sub>)<sub>2</sub>, S(O)R<sub>22</sub>, SO<sub>2</sub>R<sub>22</sub>, SO<sub>2</sub>N(R<sub>23</sub>)<sub>2</sub>,

NR<sub>23</sub>CO<sub>2</sub>R<sub>22</sub>, NR<sub>23</sub>CON(R<sub>23</sub>)<sub>2</sub>, COR<sub>23</sub>, CO<sub>2</sub>R<sub>23</sub>, CON(R<sub>23</sub>)<sub>2</sub>, NR<sub>23</sub>SO<sub>2</sub>R<sub>22</sub>, C<sub>1-15</sub> alkyl, C<sub>2-15</sub> alkenyl, C<sub>2-15</sub> alkynyl, heterocyclyl, aryl, and heteroaryl, wherein the alkyl and aryl substituent are optionally substituted with 1 substituent selected from the group consisting of halo, NO<sub>2</sub>, CF<sub>3</sub>, CN, OR<sub>23</sub>, SR<sub>23</sub>, N(R<sub>23</sub>)<sub>2</sub>, S(O)R<sub>22</sub>, and SO<sub>2</sub>R<sub>22</sub>

- 5           3.       A compound of claim 1 wherein R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, R<sub>4</sub> and R<sub>5</sub> are each independently selected from the group consisting of hydrogen, halo, CF<sub>3</sub>, OR<sup>20</sup>, C<sub>1-5</sub> alkyl, C<sub>2-5</sub> alkenyl, or C<sub>2-5</sub> alkynyl, wherein the alkyl substituent is optionally substituted with CF<sub>3</sub>;

R<sub>6</sub>, R<sub>7</sub> and R<sub>8</sub> are each independently selected from the group consisting of hydrogen or C<sub>1-3</sub> alkyl; and

- 10           R<sub>15</sub>, R<sub>16</sub>, R<sub>17</sub>, R<sub>18</sub>, and R<sub>19</sub> are each independently selected from the group consisting of hydrogen, halo, CF<sub>3</sub>, CN, OR<sub>23</sub>, COR<sub>23</sub>, CO<sub>2</sub>R<sub>23</sub>, CON(R<sub>23</sub>)<sub>2</sub>, C<sub>1-15</sub> alkyl, C<sub>2-15</sub> alkenyl, C<sub>2-15</sub> alkynyl, heterocyclyl, aryl, and heteroaryl, wherein the alkyl and aryl substituent are optionally substituted with 1 substituent selected from the group consisting of halo, NO<sub>2</sub>, CF<sub>3</sub>, CN, OR<sub>23</sub>, SR<sub>23</sub>, N(R<sub>23</sub>)<sub>2</sub>, S(O)R<sub>22</sub>, and SO<sub>2</sub>R<sub>22</sub>;

- 15           R<sub>22</sub> is selected from the group consisting of C<sub>1-15</sub> alkyl, aryl, or heteroaryl, wherein the alkyl and aryl substituents are optionally substituted with 1 substituent selected from the group consisting of halo, alkyl, monoalkylamino, dialkylamino, alkyl amide, aryl amide, heteroaryl amide, CN, O-C<sub>1-6</sub> alkyl, CF<sub>3</sub>, or heteroaryl; and

- 20           R<sub>23</sub> is selected from the group consisting of H, C<sub>1-8</sub> alkyl, aryl, or heteroaryl, wherein the alkyl and aryl substituents are optionally substituted with 1 substituent selected from the group consisting of halo, -O-C<sub>1-3</sub> alkyl, or CF<sub>3</sub>.

4.       A compound of claim 1 wherein R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, R<sub>4</sub> and R<sub>5</sub> are each independently selected from the group consisting of hydrogen, halo, CF<sub>3</sub>, OR<sup>20</sup>, C<sub>1-3</sub> alkyl, C<sub>2-3</sub> alkenyl, or C<sub>2-3</sub> alkynyl, wherein the alkyl is optionally substituted with CF<sub>3</sub>;

- 25           R<sub>6</sub>, R<sub>7</sub> and R<sub>8</sub> each independently selected from the group consisting of hydrogen or methyl;

- 30           R<sub>15</sub>, R<sub>16</sub>, R<sub>17</sub>, R<sub>18</sub>, and R<sub>19</sub> are each independently selected from the group consisting of hydrogen, halo, CF<sub>3</sub>, CN, OR<sub>23</sub>, COR<sub>23</sub>, CO<sub>2</sub>R<sub>23</sub>, CON(R<sub>23</sub>)<sub>2</sub>, C<sub>1-8</sub> alkyl, C<sub>2-8</sub> alkenyl, C<sub>2-8</sub> alkynyl, heterocyclyl, aryl, and heteroaryl, wherein the alkyl and aryl substituent are optionally substituted with 1 substituent selected from the group consisting of halo, CF<sub>3</sub>, and OR<sub>23</sub>;

- R<sub>22</sub> is selected from the group consisting of C<sub>1-4</sub> alkyl, aryl, or heteroaryl, wherein the alkyl and aryl substituents are optionally substituted with 1 substituent selected from the group consisting of halo, alkyl, O-C<sub>1-3</sub> alkyl, or CF<sub>3</sub>; and

$R_{23}$  is selected from the group consisting of H,  $C_{1-5}$  alkyl, aryl, or heteroaryl, wherein the alkyl and aryl substituents are optionally substituted with 1 substituent selected from the group consisting of halo, -OMe, or  $CF_3$ .

5. A compound of claim 1 wherein

5  $m = 1$ ;  $n = 1$ ;

$R^1$ ,  $R^2$ ,  $R^3$ ,  $R^4$  and  $R^5$  are each independently selected from the group consisting of hydrogen, halo,  $CF_3$ ,  $OR^{22}$  and  $C_{1-4}$  alkyl and wherein  $R^{22}$  is a  $C_{1-3}$  alkyl;

$R^6$ ,  $R^7$  and  $R^8$  each independently selected from the group consisting of hydrogen and  $C_{1-3}$  alkyl;

10  $R_9$ ,  $R_{10}$ ,  $R_{11}$ , and  $R_{12}$  are each independently selected from the group consisting of hydrogen and  $C_{1-4}$  alkyl, or  $R_9$  and  $R_{10}$  may together form a carbonyl, or  $R_{11}$  and  $R_{12}$  may together form  $-(CH_2)_P$  where P is 2-6 or carbonyl;

$R_{13}$  and  $R_{14}$  are each independently selected from  $C_{1-4}$  alkyl;

15  $R^{15}$ ,  $R^{16}$ ,  $R^{17}$ ,  $R^{18}$ , and  $R^{19}$ , are each independently selected from the group consisting of hydrogen, halo,  $CF_3$ , CN,  $OR^{22}$ ,  $S(O)R^{22}$ ,  $SO_2R^{22}$ ,  $SON(R^{22})_2$ ,  $CON(R^{22})_2$ ,  $C_{1-4}$  alkyl wherein  $R^{22}$  is  $C_{1-3}$  alkyl, or  $R^{15}$  and  $R^{16}$  may together form  $-CH=CH-CH=CH-$ , or  $R^{16}$  and  $R^{17}$  may together form  $-OCH_2O-$ ; and

20  $R_{22}$  is selected from the group consisting of  $C_{1-4}$  alkyl, aryl, or heteroaryl, wherein the alkyl and aryl substituents are optionally substituted with 1 substituent selected from the group consisting of halo, alkyl,  $O-C_{1-3}$  alkyl, or  $CF_3$ .

6. The compound of claim 5 wherein  $R^1$ ,  $R^2$ ,  $R^3$ ,  $R^4$  and  $R^5$  are each independently selected from the group consisting of hydrogen,  $OR^{22}$  and  $C_{1-4}$  alkyl and wherein  $R^{22}$  is a  $C_{1-3}$  alkyl.

25 7. The compound of claim 5 wherein  $R^6$ ,  $R^7$  and  $R^8$  each independently selected from the group consisting of hydrogen and methyl.

8. The compound of claim 5 wherein  $R^9$ ,  $R^{10}$ ,  $R^{11}$ , and  $R^{12}$  are each independently selected from the group consisting of hydrogen and  $C_{1-3}$  alkyl, or  $R^9$  and  $R^{10}$  may together form a carbonyl, or  $R^{10}$  and  $R^{11}$  may together form  $-CH_2CH_2CH_2CH_2-$  or carbonyl.

30 9. The compound of claim 5 wherein  $R^{13}$  and  $R^{14}$  are each independently selected from  $C_{1-4}$  alkyl.

10. The compound of claim 5 wherein  $R^{15}$ ,  $R^{16}$ ,  $R^{17}$ ,  $R^{18}$ , and  $R^{19}$ , are each independently selected from the group consisting of hydrogen, halo,  $CF_3$ , CN,  $OR^{22}$ ,  $C_{1-2}$  alkyl wherein  $R^{22}$  is  $C_{1-3}$  alkyl, or  $R^{15}$  and  $R^{16}$  may together form  $-CH=CH-CH=CH-$ , or  $R^{16}$  and  $R^{17}$  may together form  $-OCH_2O-$ .

11. A compound of claim 1 wherein  $R^1$ ,  $R^2$ ,  $R^3$ ,  $R^4$  and  $R^5$  are each independently selected from the group consisting of hydrogen and  $C_{1-2}$  alkyl;

$R^6$ ,  $R^7$  and  $R^8$  each hydrogen;

$R_9$ ,  $R_{10}$ ,  $R_{11}$ , and  $R_{12}$  are each independently selected from the group consisting of  
5 hydrogen and  $C_{1-2}$  alkyl;

$R_{13}$  and  $R_{14}$  are selected from the group consisting of hydrogen and  $C_{1-2}$  alkyl; and

$R^{15}$ ,  $R^{16}$ ,  $R^{17}$ ,  $R^{18}$ , and  $R^{19}$ , are each independently selected from the group consisting of hydrogen, halo,  $CF_3$ ,  $OR^{22}$ , or methyl wherein  $R^{22}$  is  $C_{1-3}$  alkyl, or  $R^{15}$  and  $R^{16}$  may together form  $-CH=CH-CH=CH-$ , or  $R^{16}$  and  $R^{17}$  may together form  $-OCH_2O-$ .

10 12. The compound of claim 11 wherein  $R^2$ ,  $R^3$ , and  $R^4$  are each hydrogen.

13. The compound of claim 11 wherein  $R^1$  and  $R^5$  are each methyl.

14. The compound of claim 11 wherein  $R^6$ ,  $R^7$  and  $R^8$  each hydrogen.

15. The compound of claim 11 wherein  $R^9$ ,  $R^{10}$ ,  $R^{11}$ , and  $R^{12}$  are each hydrogen.

16. The compound of claim 11 wherein  $R^{13}$  and  $R^{14}$  are each selected from the  
15 group consisting of hydrogen and  $C_{1-2}$  alkyl.

17. The compound of claim 11 wherein  $R^{15}$  is selected from the group consisting of methoxy, hydrogen and Cl, or  $R^{15}$  and  $R^{16}$  may together form  $-CH=CH-CH=CH-$ .

18. The compound of claim 11 wherein  $R^{16}$ ,  $R^{17}$ ,  $R^{18}$ , and  $R^{19}$ , are each independently selected from the group consisting of hydrogen and or  $R^{16}$  and  $R^{17}$  may together  
20 form  $-OCH_2O-$ .

19. The compound of claim 11 wherein  $R^2$ ,  $R^3$ , and  $R^4$  are each hydrogen and  $R^1$  and  $R^5$  are each methyl.

20. The compound of claim 1 wherein

$m=1$ ;  $n=1$ ;  $o=1$ ;

25  $R^2$ ,  $R^3$ , and  $R^4$  are each hydrogen and  $R^1$  and  $R^5$  are each methyl;

$R^6$ ,  $R^7$ ,  $R^8$ ,  $R^9$ ,  $R^{10}$ ,  $R^{11}$ , and  $R^{12}$  are each hydrogen;

$R^{13}$  and  $R^{14}$  are each selected from the group consisting of hydrogen and  $C_{1-2}$  alkyl;

$R^{15}$  is selected from the group consisting of methoxy, hydrogen and Cl, or  $R^{15}$  and  $R^{16}$  may together form  $-CH=CH-CH=CH-$ ; and

30  $R^{16}$ ,  $R^{17}$ ,  $R^{18}$ , and  $R^{19}$ , are each independently selected from the group consisting of hydrogen and or  $R^{16}$  and  $R^{17}$  may together form  $-OCH_2O-$ .

21. A compound of claim 1 selected from the group consisting of N-(2,6-dimethylphenyl)-2-[(2-{[2-hydroxy-3-(2-methoxyphenyl)propyl]methylamino}ethyl)methylamino]acetamide, N-(2,6-dimethylphenyl)-

2-({2-[(2-hydroxy-3-naphthylpropyl)methylamino]ethyl}methylamino)acetamide, N-(2,6-dimethylphenyl)-2-[(2-{{2-hydroxy-3-(2-methoxyphenoxy)propyl}methylamino}ethyl)methylamino]acetamide, 2-({2-[(3-(2H-benzo[d]1,3-dioxolen-5-yloxy)-2-hydroxypropyl)methylamino]ethyl}methylamino)-N-({2,6-dimethylphenyl})acetamide, 2-[(2-{{3-(2,6-dichlorophenoxy)-2-hydroxypropyl)methylamino}ethyl}methylamino)-N-({2,6-dimethylphenyl})acetamide, N-(2,6-dimethylphenyl)-2-[(2-{{2-(2-chlorophenyl)-2-hydroxyethyl}ethylamino}ethyl)ethylamino]acetamide, N-(2,6-dimethylphenyl)-2-[ethyl(2-{{ethyl[2-(2-fluorophenyl)-2-hydroxyethyl]amino}ethyl)amino]acetamide, 2-({2-[(3-(2H-benzo[d]1,3-dioxolen-5-yl)-2-hydroxypropyl)ethylamino]ethyl}ethylamino)-N-(2,6-dimethylphenyl)acetamide, 2-({2-[(3-(2H-benzo[d]1,3-dioxolen-5-yl)-2-hydroxypropyl)ethylamino]ethyl}ethylamino)-N-(2,6-dimethylphenyl)acetamide, N-(2,6-dimethylphenyl)-2-({3-[(2-hydroxy-3-phenylpropyl)methylamino]propyl}methylamino)acetamide, and 2-({3-[(3-(2H-benzo[d]1,3-dioxolen-5-yl)-2-hydroxypropyl)methylamino]propyl}methylamino)-N-(2,6-dimethylphenyl)acetamide.

22. A method of treatment comprising administering a therapeutically effective amount of a compound of claim 1 to a mammal in need of a treatment selected from the group consisting of protecting skeletal muscles against damage resulting from trauma, protecting skeletal muscles subsequent to muscle or systemic diseases, treating shock conditions, preserving donor tissue and organs used in transplants, or treating cardiovascular diseases.

23. The method of claim 22 wherein the cardiovascular disease is selected from the group consisting of atrial and ventricular arrhythmias, Prinzmetal's (variant) angina, stable angina, exercise induced angina, congestive heart disease, or myocardial infarction.

24. The method of claim 22 wherein the therapeutically effective amount ranges from about 0.01 to about 100 mg/kg weight of the mammal.

25. The method of claim 22 wherein the mammal is a human.

26. A pharmaceutical composition comprising the compound of claim 1 and one or more pharmaceutical excipients.

27. The pharmaceutical composition of claim 26 in the form of a solution.

28. The pharmaceutical composition of claim 26 wherein in a form selected from the group consisting of a tablet or a capsule.





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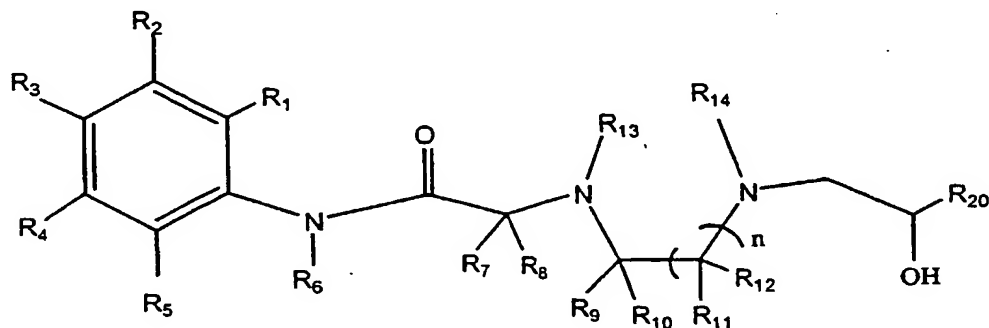
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(54) Title: SUBSTITUTED ALKYLENE DIAMINE COMPOUNDS



(I)

(57) Abstract: Novel compounds of the general formula (I) and pharmaceutically acceptable acid addition salts thereof, wherein the compounds are useful in therapy to protect skeletal muscles against damage resulting from trauma or to protect skeletal muscles subsequent to muscle or systemic diseases such as intermittent claudication, to treat shock conditions, to preserve donor tissue and organs used in transplants, in the treatment of cardiovascular diseases including atrial and ventricular arrhythmias, Prinzmetal's (variant) angina, stable angina, and exercise induced angina, congestive heart disease, and myocardial infarction.

## INTERNATIONAL SEARCH REPORT

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## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 C07C237/04 C07D317/64 C07D317/58 A61K31/167 A61K31/36

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, BEILSTEIN Data, CHEM ABS Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 211 878 A (SMITH LESLIE H) 8 July 1980 (1980-07-08) column 5, line 1 -column 5, line 44 column 5, line 66 -column 6, line 4 example 13 ---	1-28
A	US 4 567 264 A (KLUGE ARTHUR F ET AL) 28 January 1986 (1986-01-28) cited in the application column 1, line 31 -column 2, line 7 claims ---	1-28
A	US 5 506 229 A (DOW ROBERT J ET AL) 9 April 1996 (1996-04-09) cited in the application column 2, line 37 - line 26 --- -/--	1-28



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Patent family members are listed in annex.

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## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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